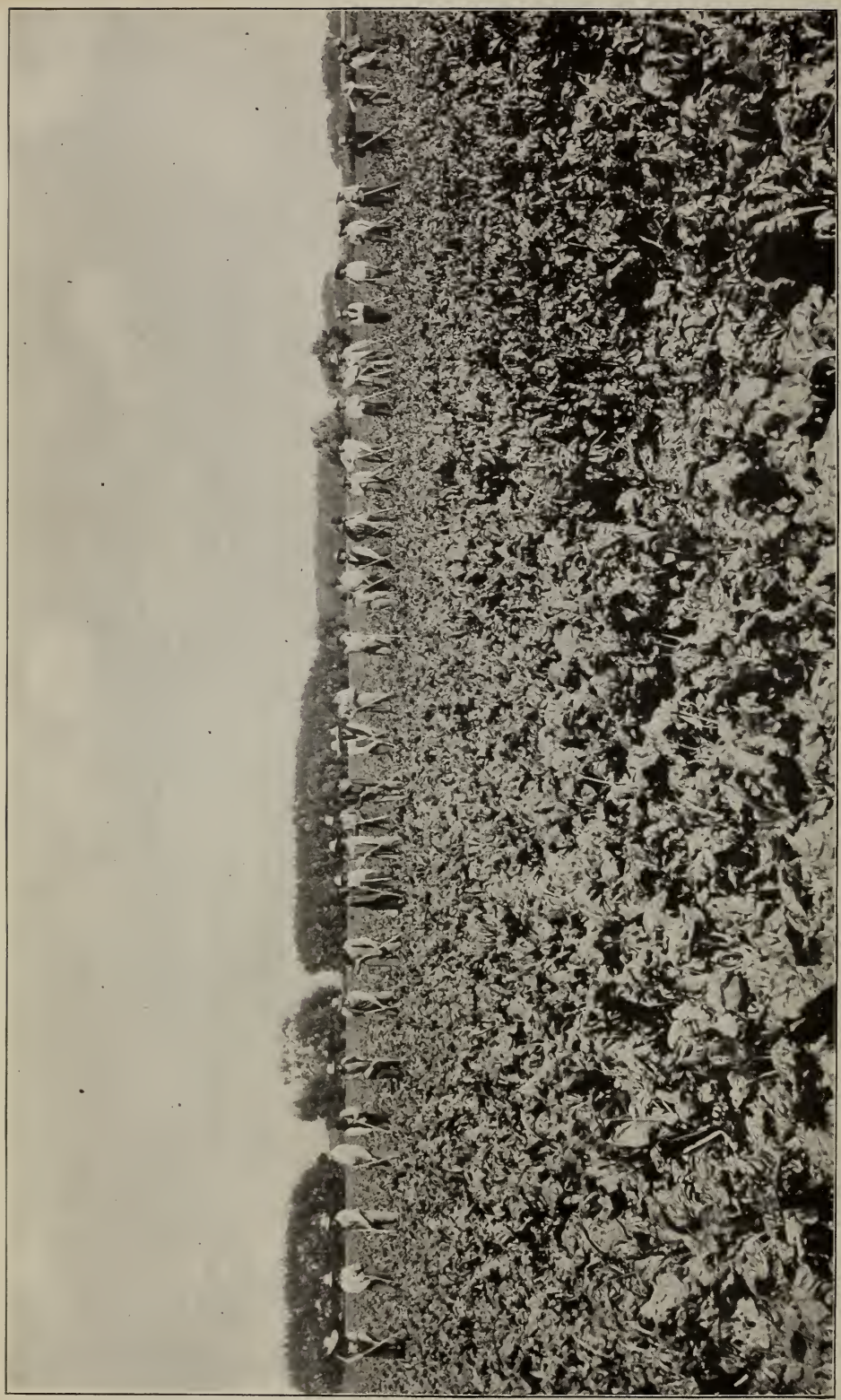

HOEING BEETS, NEAR AMES, NEBR.

U. S. DEPARTMENT OF AGRICULTURE.

Report No. 74.

PROGRESS

OF THE

BEET-SUGAR INDUSTRY

IN THE

UNITED STATES

IN

1902.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1903.

PREFACE.

The report on the Progress of the Beet-Sugar Industry for the year 1902 comprises the following papers:

(1) The annual report of Charles F. Saylor, special agent for the investigation of the sugar industry, showing the present status of the beet-sugar industry in the United States and the progress made during 1902, and including also a somewhat exhaustive discussion of "Sugar-beet pulp as animal food."

(2) Two papers submitted by B. T. Galloway, Chief of the Bureau of Plant Industry, the first by J. E. W. Tracy, of that Bureau, on "Sugar-beet seed: Its importance and production," and the second by Truman G. Palmer on "Single-germ beet balls and other suggestions for improving sugar-beet culture."

(3) A discussion of "The principal insect enemies of the sugar beet," with numerous illustrations, by F. H. Chittenden, of the Division of Entomology.

Previous reports on this subject have in nearly all cases been sent to the President, transmitted by him to Congress, and issued as Congressional documents; but as the last Congress had adjourned before it was practicable to complete the preparation of this matter, it seems advisable that this report be issued as a Department publication without awaiting the next meeting of Congress.

GEO. WM. HILL,
Editor and Chief, Division of Publications.

WASHINGTON, D. C., *June 6, 1903.*

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REPORT OF SPECIAL AGENT,

CHARLES F. SAYLOR.

LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SPECIAL AGENT,
Washington, D. C., May 2, 1903.

SIR: I submit herewith for your inspection and approval the manuscript of my report for 1902 as special agent for the investigation of the beet-sugar industry. It includes a general discussion of the status and needs of the beet-sugar industry in the United States, a showing of the progress made during the past year, a forecast of developments in factory building during 1903, statistics of the industry, a discussion of sugar-beet pulp as animal food, and other matters relating to the industry.

Respectfully,

CHAS. F. SAYLOR, *Special Agent.*

HON. JAMES WILSON,
Secretary of Agriculture.

INTRODUCTION.

In reporting on the progress of beet-sugar industry in the United States for 1902, I do so with a feeling of satisfaction inspired by a more nearly complete realization of hopes than was the case when I made my last report. Not only have more and larger factories been installed, but many of those in operation have largely increased their working capacity. Even in the face of some unfavorable aspects, which many feared would be harmful, the industry has steadily progressed to a firm footing with bright prospects for the future. A few years ago the beet-sugar industry seemed destined to make at best very slow progress in public favor. Very little was said about it in the public press, and this was confined to the special agricultural journals. Capitalists had but a vague notion of its resources and requirements, farmers and business men looked upon it as a fad, and it looked

as if, like other enterprises of the kind, this industry must necessarily go through a long and tedious period of agitation, education, and experiment. But presently it became a subject of Congressional action, and then came prominently before the country and received thorough discussion not only in both Houses of Congress, but in all the journals of the country, in clubs and associations, and in the homes of the people. Every phase of the beet-sugar industry has been canvassed in the newspapers, even papers of local circulation having contained many columns of discussion regarding the industry. Out of this has evolved a wider, more definite, and complete public information on the subject. It would be difficult to find a person of average intelligence and education in the United States who could not give some sort of general information on beet sugar and sugar beets. The people of the United States now fully understand that sugar is usually the largest item in the list of imports into the United States, aggregating in 1902 $84,871,299 in value. By producing our own sugar every dollar of this could have been kept at home, giving employment to our own laborers, farmers, and business men, and a good investment for $750,000,000 of capital.

The industry to-day has a bright future. With the signing of the protocols of the European sugar-producing countries and Great Britain, at the Brussels Conference, the artificial stimulus to overproduction of the world's sugar ended, placing the sugar industry of this country on a basis subject to no laws but those of its own enactment and those naturally evolved from healthful trade relations. The cartell of Germany will no longer place sugar on our markets at less than the cost of manufacturing it. There is an end to the unnatural arrangement which compelled the people of several European countries to pay a heavy tax on the sugar they consumed in order to subsidize the sugar exported, and thus enable the manufacturers to sell in other countries at less than the cost of production.

The country is to be congratulated on the building up of an industry that brings so many benefits to all other branches of agricultural industry, and at the same time opens up such a large field for the investment of capital and the employment of labor.

The fortunate fact that such a large area in our country having such different climatic conditions is available for growing sugar beets is one of the reasons why the industry has developed so rapidly. A few years ago the only information that could be secured regarding the growing of sugar beets in this country and the character of the beets that could be grown was that supplied by the State experiment stations and the Division of Chemistry of the Department of Agriculture. At present a factory in actual operation and the practical production of sugar beets by experienced farmers can be seen and studied by those interested without traveling a great distance. To-day the sugar

factories and beet fields all over the country are public school grounds and laboratories for actual information and illustration to capitalists, farmers, and business men. One can learn more in a day's observation in the beet field and the sugar factory than he could possibly learn with a diligent study of all the matter that was published during the experimental period of the industry. We have practically settled the main questions as to the possibility and probability of growing sugar beets, and as to their profitableness when compared with other field crops. The beet-sugar industry has come to stay and shows every indication of a profitable career. It is accomplishing results in a great many directions not anticipated in its inception. Ten years ago we had millions of acres of land throughout the arid West that seemed unfit for any purpose other than a sparse growth of grass and browse for horses, sheep, and cattle, 10 to 20 acres being required to support a single steer. This land was worth on the market from a dollar an acre down, rarely more, unless it contained mineral deposits. Most of this land was capable of growing grains, potatoes, alfalfa, etc., if water could be secured for irrigation. The people of the West have been working for laws for the development of their irrigation resources. The results of sugar beets under irrigation were so favorable that factories were built; the results of these factories again were so favorable that this arid country became active in the establishment of sugar factories until it appears destined to be the center of the beet-sugar industry. It seems destined also to reach the highest point of sugar-beet production, as regards purity and quality. Much of this arid cheap land belongs to the Government of the United States. I believe that in the future, through the influence of beet-sugar production in enhancing the value of the lands, the Government itself will be largely the beneficiary of this great industry it has so wisely fostered. In the language of another, it has "builded better than it knew." While the arid portions depend on irrigation for producing all field crops, yet the sugar industry appeals most strongly for active Government aid in developing the irrigation resources of the West.

The best and most conclusive evidence of the success of beet-sugar production in the United States is to be found in the disposition of those having the most extended experience to rapidly increase their interests, either through increasing the capacity of their factories or becoming interested in new enterprises. Most of the factories which have had at least two years' experience with a daily capacity of 600 tons of beets are increasing their capacities from 100 to 500 additional tons, or are seriously considering such action. Those interested in beet-sugar production when I began investigating this industry six years ago have become the foremost promoters of other enterprises. At that time there were eight factories in the United States. Let us

see, now, what developments have occurred in these factories. The owners of the factory at Alvarado, Cal., had just increased its capacity from 300 tons to 800 tons of beets daily, and have since increased it to 1,000 tons daily. The capacity of a factory at Watsonville, Cal., had recently been increased up to 1,100 tons, and through the operations of this factory its promoters were encouraged to build another at Salinas, Cal., having a capacity of 3,000 tons, probably the largest beet-sugar-producing concern in the world. While this factory has not yet succeeded in securing enough beets to supply this enormous capacity for a full campaign, every year the product of beets increases, and its owners look for the complete realization of its original plan in the immediate future. At Los Alamitos, Cal., there was a small factory of 350 tons that doubled its capacity the second year. Chino, Cal., had a small factory having a daily capacity of 350 tons, and this has been increased to 1,100 tons, the same company operating factories at Grand Island and Norfolk, Nebr., of 350 tons each, the operation of which probably inspired the one at Chino. After operating factories at these three places this company installed a factory at Oxnard, Cal., having a daily capacity of 2,000 tons, and the next year another at Rockyford, Colo., having a daily capacity of 1,000 tons, and has several other projects in contemplation for the near future. The Lehi (Utah) factory had a capacity of 350 tons, and during the last four years at different times it has constructed three auxiliary stations, each having a daily capacity for slicing 350 tons of beets. At these stations the process is simply carried far enough to extract the juice, which is piped to the main factory from distances ranging from 10 to 20 miles, where the sugar is manufactured. This gives this factory a combined capacity of about 1,400 tons of beets per day. It is understood that some of the projectors of this enterprise have been interested in the factories erected at Ogden, Utah, La Grande, Oreg., and Greeley, Colo., and the new large concern recently organized in Idaho. This company is now building a new factory in the Bear River Valley, Utah. This shows that the parties interested in the original eight factories have, in the aggregate, more than quadrupled their interests in beet-sugar production. Those operating the factory at Ogden, Utah, after two years' experience, instituted another at Logan, Utah, having a capacity of 400 tons. Many of the parties in Michigan interested in factories have become identified with later enterprises in the State or in Canada and Wisconsin. Most of the factories in Michigan which started with small capacities are doubling or materially increasing their capacities after operating one year. It may be assumed that the people possessing the best evidence are the best judges of the success of the sugar industry, and that largely increased and additional investments are strong proofs of the success of the industry.

At present the most important thing for consideration in the beet-sugar industry is the production of beets. Looking over the various important influences contributing to the future development and comparing with results in the older beet-sugar countries, I should say what we need is more beets for the factories and a higher tonnage per acre for the farmer. The average length of the working campaign in 1901 was 88.2 days. The average length of the working campaign in 1902 was 94[a] days. In order to accomplish the best results and secure all the economies of sugar production, the average length of the campaign in this country should not be less than 100 days. It should be our endeavor to make it more than that, and I confidently believe that it will be more than that.

The responsibility for the future progress of the sugar industry is largely thrown upon the farmers. It costs a large sum of money to build a beet-sugar factory. The money representing the investment in the factory must remain idle a large part of each year. It is clear that the factory can reach the best results when it secures enough beets to give it a maximum period of employment. This makes it desirable that more farmers in the vicinity of a factory shall grow beets, and that those who do grow beets shall grow larger tonnage per acre, in order that the crop shall be more profitable. Larger acreage benefits the factory; higher tonnage benefits both the factory and the farmer. It takes about 6 tons at $5 per ton, when beets are grown under rain conditions, and about 8 tons when they are grown by irrigation, to pay the cost of production. It is plain that every ton produced over these amounts contributes mainly to the farmer's profits.

In Germany and France it costs as high as $25 per acre to fertilize land growing sugar beets. In the Hawaiian Islands fertilizers for growing cane cost $45 per acre. Our farmers can afford to do more fertilizing. They can afford to give more attention to cultivation. In this way they can easily double the present average tonnage per acre.

COLLATERAL BENEFITS.

The generalizer, in the examination of a piece of cloth, would dwell upon its quality, beauty, and texture as a whole. The specialist would unravel and examine the strength and perfection of each particular thread to determine its contribution of strength in mutual relation to the other threads, deriving an estimate of the whole texture. Throughout my reports during the last six years I have endeavored to give both general and analytical views of the development of the beet-sugar industry in this country, and I shall follow the same plan in this report. I will now point out some of the collateral and indirect benefits of the industry.

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[a] At a number of factories there were unusual delays on account of scarcity of coal. Eliminating these delays would reduce the length of campaign considerably.

PROMOTION OF EDUCATION.

I find that wherever any considerable interest in beet-sugar manufacturing has developed, the experiment stations and the agricultural colleges—those active agents in higher scientific culture and in the practical solution of agricultural problems—are organizing their teaching and experimental forces to meet the new duties imposed by the presence of the sugar industry. Michigan has already arranged a course for teaching young men the sciences underlying this industry, and the State experiment station is training men especially to work out the problems of the beet farmer and the sugar factory. One of the pressing needs of the industry in this country is competent and especially prepared scientific young men, who have the capacity and culture with practical experience. In the agricultural departments of California, Colorado, and Utah, the same interest is being felt and met. As the industry grows the agricultural colleges and experiment stations will furnish material for equipping these factories with the highest and best type of experts for the factory and farm. No other country has a system equal to ours for training young men in a scientific and practical way to meet the various demands of agricuture. This is the secret of our wonderful agricultural development, giving to us the leadership of the world in progressive, scientific husbandry. It is attracting the attention of other nations, and it is not uncommon to find special commissioners from them examining into the methods of our agricultural colleges and experiment stations, with a view to advising their governments thereon. The installation of beet-sugar production, stimulating as it does the best and highest scientific knowledge of factory and farm will widen the whole field of agricultural investigation.

OPPORTUNITY FOR INVESTMENT OF CAPITAL.

The wealth produced by this country is so great that our financiers have been compelled to study the resources and interests of all the other countries on the face of the earth to find avenues of profitable investment. It is a common thing to read of a company formed to exploit some business enterprise in Mexico, South America, the Tropical islands, China, Japan, or elsewhere, in fact anywhere that the restless, energetic, thoughtful American can find an avenue for investment. Often these investments are at the hazard of the peculiar customs, habits, civilization, laws, and prejudices of the country in which the enterprises are launched. The question naturally arises: "Why not exhaust our own resources for investment?" To produce the sugar we are now importing from abroad would require for the building equipment and operation of factories an investment of $750,000,000 in addition to what we have already invested. The amount to be so invested would go to our own producers for building material and

machinery, to our own laborers, both common and expert, and to our transportation companies. In order to produce this sugar, worth more than $100,000,000 annually, we would be paying out money to our farmers for beets, to laborers of the factory and farm, to coal dealers and furnishers of other supplies, to transportation companies and others. Factories would be scattered through many States, and would facilitate the distribution of money in the various localities, thus improving the general prosperity of the country.

INCREASE IN VALUE OF LANDS.

In no way are the sugar factories contributing their influence to a greater degree than in raising the money values of lands. With few exceptions the actual values of lands have largely increased immediately on the establishment of sugar factories. In some cases lands which were renting for $2 to $3 per acre, in the farming communities where factories have been constructed have brought rental values of $5 to $10 per acre, depending largely upon the location and facilities for delivering beets to the sugar factory. In the arid sections we find instances where land which recently sold at the low values given for arid grazing lands has arisen immediately upon the installation of a sugar factory to prices ranging from $50 to $100 per acre. We have an instance at Sugar City, Colo., of an expanse of wild land covering a large area without an inhabitant, which, by the aid of irrigation ditches, the raising of sugar beets, and the introduction of the sugar factory, became worth $50 to $100 per acre. The sugar company of this place had secured in a body 12,000 acres of arid lands, and it conceived the idea of growing beets on them and making them valuable. The natural source of water supply for irrigation is the Arkansas River. At the time of organizing the company, three years ago, the rights to water from the Arkansas River had been taken to the extent of the supply. This company had on its lands some natural reservoirs, known to topographers as "old lake beds," depressions which could be used for storing a large amount of water, if the same could be secured. The company secured control of a couple of lakes in the Rocky Mountains, 200 miles distant from the factory site and near the city of Leadville. These lakes were tapped and their water supply turned into the Arkansas River. Under the laws of Colorado a person furnishing water to a stream from any source not hitherto a part of its supply is entitled to take out of it at any point further along in its course the amount of water turned in less a small percentage for evaporation and seepage. The amount of water is measured, both in and out, by the State irrigation engineer. In order to get this water into its reservoirs the company constructed a ditch from the Arkansas River something like 40 miles in length, connect-

ing with the reservoirs (old lake beds) on the company's lands. In this instance, through the enterprise of this company, a large body of land was made available for growing sugar beets by bringing water 200 miles. These lands, irrigated from this supply, produce sugar beets; thus "the desert is made to blossom as the rose." Thus lands almost valueless become valuable for the production of sugar, stock, butter, cheese, poultry, etc. Where three years ago the jack rabbit and the coyote were monarchs of all they surveyed is now the center of a thriving town of 2,000 inhabitants, thrifty, prosperous, and happy in the cultivation of fertile soil and the production of finished products which give to these lands their high values.

California lands capable of general cropping and producing sugar beets are readily worth $200 per acre. Here is another instance of the influence of the sugar factory on the values of lands. It takes no inconsiderable amount of money to build and equip a factory, and once the money is invested it is of too much importance to be allowed to lie idle for want of sugar beets. From 1897 to 1901 California experienced an unprecedented drought throughout its whole extent, the beet yield ranging from a fourth to three-fourths of a crop. It occurred to those interested in the investment of so much capital in the sugar factories that something must be done to avert the effects of the drought. Deep wells were sunk, vast quantities of pure flowing water were discovered in many places, and thousands of acres were brought under irrigating ditches. Not only did these lands become more valuable, but the supply of water discovered added a valuable asset to the resources of the State for all time. Other artesian wells are going down, thus continually augmenting the arable territory subject to an abundant and perpetual supply of water.

In Idaho, Arizona, Wyoming, and Nevada many enterprises are on foot for bringing under cultivation large tracts of land hitherto considered useful only for grazing cattle and sheep. The building of sugar factories will make this land as valuable as any lands in the great agricultural States of the Mississippi Valley.

Not only do sugar factories enhance values of lands, but they are furnishing the means for payment of taxes, interest, and mortgages, making the landowner an independent freeholder, giving him better opportunities for rearing, educating, and providing for his family. This induces a higher degree of citizenship and culture and conforms to American ideals.

IMPROVEMENT IN FARMING.

The last decade has seen a wonderful transformation in the status of rural life. The farmer is no longer to be considered as following the daily routine of the quiet listless career pictured in pastoral lore; he is coming into intimate relations with the active everyday affairs

of the busy world and becoming an active participant therein. The monotony of the farmer's life is relieved by the stimulus of contact with the throbbing industrial life of the nation. He has his free mail delivery; his daily paper is brought to his door, giving him current events and daily markets; he has the telephone, and the opportunity to ride into town on the suburban street railway for a nominal sum. He is a better posted and a more competent business man than his predecessor. When we contemplate the influence and bearing this will have on the future of the farmer and his importance, we get some idea of the progressiveness of the age and the importance of the farming classes in working out the great problems of our Republic.

The sugar factory is the nucleus around which all these facilities, opportunities, and advantages gather for the most effective results. Where we get density of population coupled with the ability to thrive and progress, we have the opportunity for all these advantages. It costs about $30 an acre in humid districts and about $40 in irrigation districts to grow sugar beets. Most of this expense is for labor; hence we can readily see the large increase in the number of laborers required in a community whose leading crop is sugar beets. Where we now have large farms, from 80 acres up, we will find them cut up into smaller ones of 20, 40, or 60 acres, multiplying several times the ability of these lands to support population. The pastoral poems of the future will not so much portray the quiet serenity of rural life as the activities it presents. Such a farm life is more like suburban city life, with its advantages in the way of schools and opportunities of association.

The building up of the sugar industry furnishes more customers to the merchant and more business to the bank and stimulates business of every kind. Savings banks are more numerous and have a larger number of accounts.

INFLUENCE ON OTHER MANUFACTURING INDUSTRIES.

We often hear discussed the mutual relations existing between the farming and mining interests of the West on the one hand, and the manufacturing interests of the East on the other hand, the latter engaged in turning out the finished products required by the former, which in turn supply the crude material used by the manufacturer and food for the laborers. It is pointed out that each furnishes a market for the other and that their interests are mutual. Therefore, we should aim to develop manufacturing industries in order to furnish a home demand for the crude products of our agriculture and mining. In this connection I wish to call the attention of the manufacturers to the importance of building up in our own country beet-sugar factories, sustaining a large number of laborers on the farm and in the factory and afford-

ing a market for utensils, machinery, fuel, supplies, clothing, food stuffs, etc.

We have also concerned ourselves with building up foreign markets for our surplus products, both finished and crude. We are proud of our large export trade. I have before me the valuation of our exported manufactures for the past two years, aggregating for 1902 $403,641,401 and for 1901 $410,932,524. In each of these years steel was the largest item of export; for 1901 it was $117,319,320; for 1902 it was $98,552,562. Yet this great sum was exceeded by our imports of sugar, amounting in 1901 to $122,000,000. Consumers actually spent for sugar, both home-grown and imported, in this country in 1901 $265,664,000—nearly two-thirds the valuation of our entire exports of domestic manufactures.

Sugar is not only the most important of our imports, but it is the one which, if produced at home, is best adapted to benefit our capital, labor, and agriculture. We possess the conditions for producing all this sugar at home. If it be desirable to build up export trade in foreign countries, whose markets we must enter under all the uncertainties of competition with all the other nations of the earth, is it not vastly more important that we arrange, with conditions so especially favorable, to produce our own sugar, employing our own laborers and capital and raw material? This gives our producers the opportunity of supplying this home demand, instead of exporting to supply the needs of laborers and factories in other lands under unfavorable competition. There is probably no other article in general use the cost of which is made up so largely of labor and our own raw materials. To build up the beet-sugar industry means a more available market for all other manufactures, a market under our flag, an American market, regarded as the best in the world, open to all our manufacturers at their doors, free from competition with the products of cheap labor from all parts of the world. This is a pertinent matter for consideration at the present time. Let us produce our sugar at home, thus giving employment to an army of workmen in the construction and equipment of $500,000,000 worth of factories and another army employing $250,000,000 more of working capital in the operation of manufacturing the sugar itself. All of this is practicable. Let us seek foreign markets, but let us build home markets whenever favorable opportunities offer. Our natural conditions and resources, such as rainfall, irrigation, sunshine, and fertility of soil, the bounties of a beneficent God, appeal eloquently for utilization.

CHEAPER LIVING.

We necessarily compete with the older nations of the earth in our own markets and in those of the world against products produced by cheaper labor. It seems under our system of government, institutions,

and ideas of individual rights we are destined to do so for all time. The American principle is to rise in wages rather than decline. The aim of our institutions is toward bettering the conditions of the individual. This means a better wage and better living, a better mind, and higher culture for the laborer than in other countries. To offset the higher cost of the advantages we wish to secure and perpetuate for the individual we must produce a superior article and lessen cost of production by superior artisan ability, avoiding the lower wage scales and long hours of labor. I wish to call attention to the adaptability of the sugar industry for this purpose. It is a well-known fact that the farmer lives cheaper than most people; but in some respects he lives better; his food is fresher and more wholesome. From the nature of the case many beet-sugar factories can not be crowded together into a small area, as is the case with other factories in what are known as manufacturing centers; each must go to the locality where the beets are produced. To some extent beets are a perishable product, and freight rates for long hauls very materially add to the cost of production. For these and other reasons the factory locates in the farming area where the beets are grown. The factory stimulates meat, butter, and cheese production, and all kinds of gardening. The district surrounding a sugar factory furnishes almost everything that a man requires on his table for a good, wholesome living, and the factory workingmen can live almost as cheaply as the farmers. They have pure air, and are free from the contaminations of the congested city. This condition is much better than that of laborers who congregate in factory districts.

IMPROVEMENT OF ROADS.

Probably no other subject of interest to the rural population is receiving more attention throughout the nation than that of road improvement. One of the fundamental needs of society is a ready, practical means of communication. The experiment stations of the country are now engaged in experimental work and actual demonstration with a view to stimulating the public mind and promoting the best and cheapest systems of good road building with local material. State legislatures are enacting better laws, and in some cases the principle of State aid has been adopted. The Federal Government has established an Office of Public Road Inquiries in the Department of Agriculture. Literature has been prepared and distributed for the education of the people on this subject.

There is nothing that will work so effectually for good roads as necessity, "the mother of invention." When a beet-sugar factory is established farmers at once discover the necessity of good roads. Agitation begins, public meetings are held, and every public highway becomes the object of solicitous attention. It is found that the farmer requires at least four horses and must deliver from 2½ to 4 tons of

beets per load if he is to accomplish the best results in the saving of time and expense. Neighbors talk over road improvement, and the idea becomes infectious. A public meeting is called, public roads are discussed, and an organization is effected which goes to work for the improvement of the roads. In most instances this is accomplished even without the advantage of outside help. Among the interesting features of my work of promoting the progress of the beet-sugar industry is attendance at these local meetings, at which roads and other local subjects pertinent to the needs of these beet-growing districts are considered. Permanent road building is one of the most important matters commonly discussed.

INFLUENCE ON IMMIGRATION.

Attention has been called in recent years by the census reports to the important change that has taken place in the class of immigrants coming to the United States. Our resources and opportunities for settlement have been so great that we have encouraged immigration. The recent census reports reveal the startling information that the number of desirable immigrants from the more intelligent parts of Europe has been falling off and that immigration from the lower elements has very much increased, giving us in recent years a larger proportion of the more ignorant, vicious, disease-infected classes. This has caused us to strengthen our laws on immigration, providing against the bringing in of criminals, those liable to be paupers, and those infected with contagious diseases. As the immigrant usually becomes an American citizen, we should aim to secure the most intelligent, industrious, and law-abiding. I have observed that the sugar factories tend to draw into their service, and especially on the farms, foreigners who have had previous experience either in cultivating sugar beets or in manufacturing sugar. These people were originally drawn to this country, no doubt, by our superior advantages in general, congregating mostly in cities and towns, doing such work as they could secure as manual laborers. As sugar-beet growing increased, it presented to many an opportunity to resume the occupation in which they are most skilled, an occupation in which every member of the family can engage, down to the child of 10 years. This industrial activity of all the members of the family was the rule in the country where they came from, and it is this opportunity which appeals to them when they come here. Most of the labor in the cultivation of sugar beets comes at a time when the public schools are closed. The head of the family, for a certain consideration per acre, takes a contract for thinning, bunching, hoeing, and harvesting a crop of sugar beets, knowing that he will have use in this work for every member of his family, which is generally large. He realizes more compensation for the labor performed than he would in the country whence he came. He

acquires a good start in the world, and becomes qualified for the duties of citizenship. He and his family belong to the healthful, strong, industrial class, and soon adopt our customs, habits, ambitions, national pride, and interest, becoming excellent citizens. Through correspondence with friends in Europe, others are induced to follow their example, thus promoting a better immigration to this country. The beet-sugar factories of Europe are mainly in Germany, France, Austria-Hungary, Russia, and Sweden, and it is from these countries that sugar-beet farmers come to America.

EDUCATIONAL FORCES AT WORK IN FAVOR OF THE BEET-SUGAR INDUSTRY.

It would be hard to give a complete account of all the forces that have been operating on the public mind in favor of the beet-sugar industry. However, a brief mention of some of these various influences will not be out of place in this report. Since the aim is to foster and build up the industry, it is certainly competent to review the agencies accomplishing the results.

LEGISLATION.

Perhaps the most effective of all of these various influences at work during the last two years is public agitation incident to the consideration by Congress of sugar production, home and foreign. This has probably accomplished more in familiarizing the public with the beet-sugar industry than any other cause. Every available good thing that could be said in its favor has been made public. Every criticism that could be discovered has also been in evidence and has been thoroughly circulated. All the known advantages and disadvantages have become the common property of all intelligent readers and thinkers. Financiers know much more about beet-sugar production, and they are much better posted as to the amount of capital required for investment and the profits to be acquired thereby. The farmers throughout the country have read about the establishment of beet-sugar factories in various parts of the country from New York to California, and have a pretty definite idea of tonnage, cost of production, profits, and general benefits incident to sugar-beet growing. It suffices to say that we enter the period of 1903 with a much higher public respect and appreciation of the beet-sugar industry, a keener alertness on the part of all concerned everywhere, and a more general definite tendency of capital, business, and farming toward this industry.

THE PUBLIC PRESS.

Next in importance to the general agitation through which the industry has passed comes the work of the press. The most valuable results have been accomplished by the agricultural press, particularly

by certain papers that are devoting all their space to this one industry. Much good has also been done by journals devoted to general agriculture which are giving careful attention to this industry.

The secular press has devoted considerable space to matters pertaining to all phases of beet-sugar production. All this work is more intelligently done than formerly. This is the best evidence of general improvement of public education on this subject.

FARMERS' ORGANIZATIONS.

In sections growing sugar beets for sugar factories and in other places where the building of factories is contemplated, it is quite common for farmers to organize societies for the purpose of studying the culture of sugar beets and other pertinent questions. Papers on beet culture, covering germination, cultivation, and harvesting, and other matters of interest to the farmers, are read by those competent to furnish information on such subjects. A few years ago we could hardly find in a whole State a person who had training and knowledge sufficient to disseminate facts pertaining to this industry. The sugar factories of the country are constantly training specialists to supply this demand. The chemists and professors of our agricultural colleges have given considerable attention to the subject also, and now it is possible for any community to secure all the talent necessary, if not locally, at least within a short distance, to instruct the farmers on definite rules of culture and harvesting, and to furnish intelligent data on cost of production and profits of growing the crop. We now have in all beet-growing States local societies or unions of growers and farm laborers, county and State societies of the same, and national organizations of both. In no other field crop is so much attention given to the thorough organization of societies as in growing sugar beets. Farmers' institutes naturally take up the questions pertaining to the sugar industry, and thus we have a constant course of instruction going on, intelligently directed and effectively contributing to the upbuilding of the sugar industry.

TRAINED AGRICULTURISTS.

As a factor of education particularly affecting this industry, and indirectly the whole agricultural development, I must call attention to the employment of agriculturists by the factory organizations. The agriculturist is a person employed by the factory to superintend the growing of beets by the farmers and to arrange contracts with them providing for the factory's annual supply of beets. His relation to the farmer is largely advisory, but in some regards his directions are actually mandatory. He decides when the field of beets is ripe, issues orders to have the beets delivered, and sees that farmers comply with the various items in the contract between the farmer and the factory;

he arranges for cars, in case beets are shipped by railroad; he attends to the erection of beet dumps on the railroads in the country at available points; he superintends the crop delivery and regulations governing the tare; he visits the farmers during the preparation of the seed bed, planting, cultivation, and harvesting of the beets, and gives suggestions as to the thinning, cultivation, harvesting, etc.

In Germany the agriculturist is one of the best educated, most intelligent, and scientific men about the sugar factory. He is supposed to be acquainted with the chemical composition and the mechanical consistency of the soil, with the application of fertilizers, and the best kinds for the soil in use. He must be not only a physicist but a chemist; above all he must be a scientific agriculturist, thoroughly versed in plant nutrition and plant improvement. He is a man thoroughly posted by long, practical experience with all kinds of crops, with keeping up the fertility of the soils, and maintaining a proper equilibrium among the elements of fertility. He knows all the elements demanded by the different crops, and the proper rotation to meet the case. The sugar factories of this country are also selecting for this work the best available men; the interests of the companies require it. The work of these agriculturists serves to educate the farmers throughout the beet-sugar areas. As a permanent but less rapid source of disseminating useful information he is probably the best of all the educational forces. The usefulness of such a man in a community can hardly be overestimated. The presence and work of the agriculturist means a higher and better system of farming, not only in growing sugar beets, but in growing all crops.

Intelligence and scientific and technical knowledge are not the only requirements for a successful agriculturist. He not only has to do with the condition of plants, but he has to do with conditions of men. A mixed nationality leads to mixed traits of character. A person whose duties are so largely advisory must be one who is capable of impressing the one advised with the necessity and desirability of carrying out instructions. When his work assumes the form of actual direction, it is all the more necessary that he be a person of discretion and good judgment in administering his office. In Europe an agriculturist deals with people of his own kind, having his own habits of thought, action, and disposition, not to say instincts, which have so largely to do with our movements in life. He thoroughly understands the class of people under his supervision. The work of the agriculturist in our country is more complicated. He has to do with all kinds and classes of people, Americans and foreigners, the intelligent and the unintelligent. He must be a person of flexible character, tact, and resource in order to accomplish his purpose. The American farmer is more independent in his methods of thought and his estimate of his relation to affairs of all kinds. Even the foreigner who becomes a

citizen of the United States quickly absorbs, through his broadened freedom of action, independent ideas. Neither are subject to the same kind of oversight that obtains in the rural districts of Europe. It has been my observation that, as a rule, foreign agricultural experts employed in this country usually possess the education and scientific attainments, but fall short in administrative ability to deal with our farmers accustomed to following out their own ideas and in their own way. The agriculturist should be capable of impressing upon them the necessity of following the special rules for sugar-beet culture, and of meeting the requirements of the contracts so necessary to favorable results. An American or a foreigner who has become thoroughly initiated in our methods through long experience proves to be much more satisfactory as a rule, though usually he is not so scientific as the trained foreign agriculturist. We are rapidly developing in all of these factory districts trained men, competent to take charge of this work, equipped to meet all the conditions. I contend that the proper source of future supply for agriculturists for this industry will be found in the scientifically trained young men of our agricultural colleges who have had additional practical training in sugar-beet production. Such persons will grow up with the industry, thoroughly appreciating all of its environments, scientifically equipped to meet its problems, and practically constituted to perform his duties.

SOME RESULTS OF EXPERIENCE.

Having pointed out the agencies of education, it will be interesting to notice some of the things which have been learned.

Facts elucidated by experience are gradually correcting erroneous ideas with reference to the beet-sugar industry. As late as 1897 our own experience was derived from and limited to the few factories then in existence, most of which were in the semiarid portions of the country, only two having been established in what was known as the rain belt, these being in the east-central part of Nebraska. As sugar beets had never been grown except under rain conditions, all the available information on the subject related to the growing of beets in humid climates. This information was imported from Europe, and came as formal, lengthy, scientific discussions. Naturally, our scientists at the experiment stations studied carefully this kind of information. As a result, a very definite, inflexible, and intricate formula was announced governing the whole period of growth of sugar beets. For the people of the East, Grand Island and Norfolk, Nebr., were the objective points for practical investigation, and, naturally, it was assumed that whatever was found in vogue there must be the thing to follow in every other place where sugar beets were to be grown. These conditions led to quite a number of errors.

SOIL AND CULTIVATION.

The soil in the vicinity of the Grand Island factory is a light, loose, sandy loam. It was assumed that in order to grow beets at any other point we must have this particular kind of soil. All over the country we heard it announced that sugar beets must be grown in light sandy soil. I well remember the first serious mistake of the people of Michigan, who got the idea that their light sandy soils could be utilized in growing a productive crop of sugar beets. This idea they not only applied to their new soils, but to their light sandy soils which had been nearly exhausted by the constant growing of cereals and other crops. It was assumed that these would produce sugar beets without first restoring their fertility; but experience has shown that Grand Island was not originally an ideal selection for the location of a sugar factory, and that sugar beets, like any other heavy crop, must have the best soils to get the best results. Like corn, wheat, and potatoes, they will thrive on many kinds of soil having sufficient fertility and proper mechanical consistency. In many localities clay soil, with sufficient sand for working, is preferable to sandy loam. The sugar beet requires a fertile soil, and one in which the plant can embed itself, so as not to be forced up above the surface of the ground. It must be a soil easily penetrable by the tap root; it is through this the plant receives a considerable portion of its nutrition and especially derives its moisture, promoting its hardiness in case of drouth. It is similar to alfalfa in this respect. The set formula already referred to taught that in every instance land must be turned over to an unusual depth, and in addition thereto it must be subsoiled. Now, this is vitally necessary for a great many soils, but for others it is not; results will not pay the expense, and a sudden change from shallow to deep plowing would be harmful. In growing a crop of sugar beets on any particular piece of land the treatment must be somewhat different from that employed in growing other kinds of crops, and this treatment must be intelligently modified to suit the kind and conditions of the soil. The best information to apply in the case is that derived by experience with the land itself, obtained by growing sugar beets year after year. The great factor in future progress in this industry is the accumulation of this practical experience among our farmers.

The opportunity for decreasing the cost of production of sugar exists in two things: (1) Better and cheaper methods in the factory, and (2) the ability of the farmer to grow a larger tonnage and better beets. Working along these lines, Germany in twenty years was able to reduce her cost of sugar by one-half. I have been carefully watching the improvement in methods and results at several of our older factories. It is clear that we are going through the same process of

evolution as Germany. With experience our farmers will grow, on an average, 4 tons more per acre. They will grow beets having sugar contents at least 3 per cent higher than now. Sugar beets possessing a high content of sugar and purity not only give a larger yield of sugar per acre, but the factory can extract a larger percentage of the sugar they contain, and accomplishes the work at less expense per ton of beets. High sugar content is usually accompanied by high purity. The impurities in the beets cause the factory trouble in extracting the sugar. The farmer is gradually learning that general principles apply to sugar-beet culture only in a general way, the same as in growing other crops: they are serviceable when applied with practical experience, based on actual knowledge of the conditions affecting the particular land in question.

TIME OF PLANTING.

The old formula required planting at a particular time. Experience in the growing of other crops has shown that time of planting depends absolutely upon the season itself. Corn in Iowa is planted all the way from the middle of April to the 10th of June; the farmer has to be governed entirely by the warmth of the soil, prevalence of rain, and other conditions. It is best at times to plant early and at other times late. In actual practice we are planting sugar beets in some part of the country at almost all times of the year. Taking advantage of the flexibility of this rule of planting, time has materially aided the planters of California. A fixed time is one of the errors that has been corrected. The season is such in California that the planting of beets may occur at any time from the last of December to the first of April, and it is possible for some of the factories in that State to so arrange their planting seasons as to have beets maturing at different times, giving them a much earlier start and materially extending their campaign period. A large portion of the beets in California during the last two years were planted in January and February; several of the factories in that State were able to begin the manufacture of sugar by the middle of July, practically completing their work before the beets in Michigan, New York, Wisconsin, and Nebraska had matured. Early planting in California has materially aided sugar production in that State. The season of rainfall is during the winter months; as a rule the State has sufficient rain to germinate beets; the peculiar character of the soil is such that it holds sufficient moisture to mature the crop. This early planting induces better germination and considerable growth before the rainy season is over. It gives the beet an opportunity to send its taproot down to lower depths and thus sustain a better growth when the dry season comes on. It matures the beet earlier and gives the factory an opportunity to begin work at an earlier date.

It is clear that the rule founded upon European conditions will be found faulty when applied to agriculture under American conditions. But these are things that could only be developed by experience, and it is the solution of these problems that is making beet-sugar production a certainty.

IRRIGATION.

I have alluded to the fact that growing sugar beets by irrigation is entirely dependent upon our own experience. Extensive growing of crops by irrigation in this country is a feature of the last quarter of a century. Its application to beet culture has elucidated many facts during the last decade. The questions of when to apply irrigation and when to cease are dependent so largely upon the kind of soil and the kind of crop grown that they have to be settled largely through individual trials on each particular kind of soil. The accumulation of information as to growing sugar beets by irrigation has been rapid, and the general conclusion reached is that beets are the best and most profitable crop that can be grown by irrigation. This fact has made this crop popular throughout the arid sections of our country.

CLIMATIC CONDITIONS.

In this connection I desire to call attention to some very valuable information brought out in growing sugar beets during the past year, which apparently conflicts with the generally accepted ideas on the subject. After the establishment of the factory at St. Louis Park, near Minneapolis, Minn., the district growing the beets experienced for two years more than usual drought. All crops were materially affected. In 1900 and 1901 the drought was especially depressing. The country surrounding this factory for 100 miles in every direction is accustomed to growing principally wheat and flax, and some corn is grown. Through these two dry years other crops ran, on an average, from one-fourth to one-half a crop. Sugar beets did considerably better, reaching from three-fourths to a full crop in many cases. During this time the sugar company was having difficulty in securing sufficient acreage from the farmers for growing beets. It was able to secure only one-half to two-thirds as many beets as it had capacity to work, thus greatly reducing the length of its campaigns. The reliability of the beet crop, as compared with other crops, established during these dry years led the farmers to take up beet growing more generally, and as a result this company was able to secure sufficient acreage to produce a full supply of beets for 1902. It not only secured a full supply, but was able to select such lands as had shown the best results. Previously the factory had been compelled to go longer distances than practicable to secure contracts with farmers, even contracting with farmers in Iowa, some of them 200 miles away, for

several hundred acres. The lessons of the drought in showing the stability of beets under such conditions enabled the company to retire from distant and undesirable fields and to procure beets from better lands nearer home, thus cutting off the expense of long-distance freight charges. In 1902 this factory had an abundant supply of good beets, aggregating about 32,000 tons, running high in sugar content and purity. The farmers secured an average of over 9 tons of beets per acre. This tonnage, produced at an estimated cost of $30 per acre for growing beets, yielded about $14 profit per acre. In the cost of $30 per acre for growing beets is included full compensation for the farmer's time, the use of his teams, implements, etc., so that his profits are clear.

In this connection mention should be made of some further information gained by the experience of 1902 in Minnesota. Through this entire season excessive rains prevailed from the time the beets were planted; in the early part of the season considerable acreage was washed out requiring replanting; in a few instances the crop was lost entirely and the land was put in crops of other kinds. But, while the beet crop was affected to a limited degree in the number of acres cultivated, those harvested gave an unusual yield, while the excessive rainfall on other crops was as disastrous as the former drought. Here we have a double illustration, showing the advantages of growing sugar beets as compared with other crops under extreme drought and excessive rainfall. It is needless to say that the farmers of this locality are convinced. I was permitted to examine quite a number of letters from them to the manager, which unanimously expressed the sentiment that for that locality the staple crop should be sugar beets, and I noticed in these letters statements to the effect that the beet crop was the one on which they relied with assurance for the payment of their taxes, mortgages, interest, etc.

The conditions just described were not confined to Minnesota. The same things happened in Michigan and Nebraska. Throughout all of the Middle West excessive rainfall was the rule; nearly all kinds of crops were seriously damaged; but as a rule it was a very favorable year for sugar beets.

The results of beet growing under the excessive rainfall of the past year were apparently in conflict with a well-established belief concerning the nature of the sugar beet, namely, that in a dry season it will show a higher percentage of sugar. This belief had been confirmed by the results obtained during the two previous dry seasons when the beets were generally high in sugar content. The same thing had been observed in Nebraska during some former dry periods, as well as during the years 1900 and 1901. It was believed, on the contrary, that a wet season, especially during the latter part of the period of growth, would tend to lessen the percentage of sugar and lower the purity of

the beets. But the opposite has been shown by the results of the past wet season. Beets showed up remarkably high in sugar content and purity, though the rainfall continued to be excessive throughout their growth to the time of harvesting. I have not seen this matter discussed by our scientists, but I suggest that it is one worthy of discussion. My own opinion is this: The rule still holds good; sugar beets will be lower in the sugar content under the influence of continued rainfall during the latter part of their growth probably for two reasons: (1) The beet takes up considerably more water, causing the sugar in the beet to be lower in comparison with other contents; (2) if these rains are warm they induce a second growth of the beet, causing it to put out lateral roots and causing the inversion of some of the sugar already stored. It will be remembered that the excessive rains of the fall of 1902 were generally cold and not conducive to growth. Perhaps another explanation may be found in the fact that these continuous rains started early in the period of growth of the beets and continued throughout their growth. In many cases it was very difficult to get into the fields for the purpose of thinning and cultivating, and a great deal of difficulty was experienced from the moist, soft condition of the soil when the beets were ready for the harvest. It would be interesting to have the views of scientists as to why the crop of beets throughout the country last year showed such remarkably high sugar contents everywhere in the presence of so much rainfall, even up to the very day they were harvested.

WORK OF PROMOTERS.

The general prominence of the industry in the business world has greatly increased during the past year. Promoters are dealing more generally with the merits of the industry, and are actuated less with the hope of some extraordinary compensation in the way of bounties, bonuses, concessions, etc. We hear no longer of promoters asking large concessions or privileges, donations of land and contributions of money over and above an interest inspired by prospective values of stocks and bonds or dividends of the enterprise. A promoter nowadays is so from the fact that he has a definite proposition from which he expects to realize profits, based on the operations of the factory itself. He may be a designer, a manufacturer of machinery, or a capitalist. Through all of his negotiations appears a healthful, strong belief in the ultimate and definite paying ability of the concern he is promoting. His askings rarely go beyond the point of a location for a site, privilege of water for his factory, and drainage from it, railroad switches, other necessary conveniences, and possibly a remission of taxes for a short time. This kind of promotion carries with it more of the air of faith and inspires more of confidence.

ATTITUDE AND INFLUENCE OF RAILROADS.

I have been impressed during the past year with the changed attitude of the railroads. Hitherto they have been inclined simply to consider matters called to their attention pertaining to the establishment or operation of sugar factories along their lines, manifesting interest more in an indirect than a direct manner. It was a matter of considerable gratification during the past summer to learn that nearly all the railroad lines were giving active encouragement to the installation of sugar enterprises and helping those already built; they are realizing more the helpfulness of the beet-sugar patron, and contributing more in an active way to the upbuilding and needs of the industry. They are becoming more liberal in the matter of freight rates, which is eminently necessary, since high freights tend to restrict the beet-growing and sugar-market areas of the sugar factory. As the sugar product increases in quantity and becomes more and more a feature of railroad transportation, the railroads of necessity are becoming more alive to their relation, and no doubt in the near future will be among the most active factors in promoting the sugar industry. There are many places in the United States where the shipping due directly and indirectly to the sugar factory will be the most important item in the railroad business. In the States of Michigan and Wisconsin some railroads were originally built practically to convey the logs to the sawmills and the lumber to market. This business has been nearly completed; the roads are there but their business has very much diminished. The sugar factories will largely replace the lumber industry as a means of furnishing business for these roads in hauling the beets, coal, coke, lime-rock, and all the other crude materials used, and conveying to market thousands of tons of sugar, cattle, butter, and cheese, resulting directly or indirectly from the operation of the factories. As an indication of the effect of sugar production on transportation, I insert a clipping from the Denver (Colo.) Republican of January 30, 1903:

GREELEY, COLO., *January 29* (*Special*).—C. A. Granger, vice-president and manager of the Greeley Beet Sugar Company, to-day received a telegram from C. S. Morey, president of the company, who is in the East, that all arrangements have been made for building a railroad from Greeley into the Pleasant Valley and Lone Tree district east of town, providing the farmers of that section would contract to raise 2,500 acres of beets for the Greeley sugar factory for the coming season. This railroad is to be distinctly a beet-sugar proposition and will be handled in all its interests by the Greeley Sugar Company for the benefit of the farmers and that company.

The contemplated road is to be about 14 miles in length, and will give the farmers of one of the most productive sections of the Poudre Valley a chance to place their beets and all other products on the market at the lowest cost for transportation. The road will also open up a section of country lying to the east of Pleasant Valley which has not been extensively farmed, owing to the distance from a market.

The railroad committee of the Greeley Board of Trade is taking active interest in the road and doing all in its power to further its construction.

I notice that many of the new enterprises contemplated have as a feature the introduction of the trolley electric roads for delivery of beets. Factories already established are introducing this system of local transportation. It appears quite probable that in this way, and to supply power for other purposes electricity will play an important part in the beet-sugar industry.

CHANGE IN ATTITUDE OF CAPITALISTS.

In the beginning capital was slow in taking an interest in beet-sugar production, owing largely to the prevailing lack of information throughout the country as to the production of sugar beets. We were so accustomed to look upon the Tropics as the natural source of supply of sugar that we felt that we could not compete with the cane product on account of our high cost of labor, coupled with the necessity for high cultivation. Further investigation revealed that Europe, in the production of beet sugar, had rapidly outstripped the producers of the Tropics. Of the total sugar produced in the world in 1901, that from beets constituted 65.4 per cent. In looking for the causes which brought about this rapid ascendency of beet sugar it was found that the beet-sugar countries of Europe had rapidly reduced their cost of production through the efficiency of farmers and factory workers; that they were doing this even with fewer advantages than those possessed by the United States. They were producing this sugar on land of high value, requiring a large constant expenditure for fertilization. With our great stock interests so much benefited by the feeding products of the sugar factory, this question naturally occurred to our capitalists: "Why can not we, on our cheaper lands, which are naturally fertile, compete with the Tropics and even with Europe in the production of sugar?" Capital much quicker appreciates such advantages than any other factor in business enterprise. I think it is fair to state that capital stands in readiness to furnish money sufficient to build up this industry wherever it can be shown that the conditions are right and the farmers are ready to furnish the beets. My correspondence and observations on every hand indicate this. In studying the great number of efforts now being put forth to secure the building of beet-sugar factories I have been impressed with the fact that the work is mainly directed toward securing sufficient contracts with the farmers, assurances from boards of trade, and concessions from cities and towns regarding sites and other privileges. We have disabused the minds of the capitalists of erroneous beliefs regarding the possibilities of sugar production, which is a long step and fraught with great future possibilities.

A few years ago there were very few capitalists giving the beet-sugar industry any especial attention; those few were confined to experienced sugar producers, who had given considerable investigation to beet-sugar production. There was nothing like a general

acquaintance with the industry among capitalists. It was necessary to build the first score or more of factories and allow their bonds and stocks to go on the market in order to acquaint investors with the industry and arouse the interest of capitalists. Factory building could not proceed any faster than money was available for the purpose. To-day it is one of the aggressive agents in promoting the industry.

PUBLIC PREJUDICE.

Beet sugar, not unlike every other new product, has had to meet prejudice resulting largely from ignorance. At one time the idea was quite prevalent that beet sugar was not so good as cane sugar. While scientists and sugar experts could tell no difference between good samples of the two, the public verdict was that beet sugar is inferior for a great many purposes, such as fruit preserving, canning, etc. The scientists say that sugar from either cane or beets, when purified through refining, is exactly the same, and both are known to them as "cane sugar." But a considerable portion of the press and the people made a distinction and attributed inferior quality to beet sugar. I think this error grew out of the failure of the people to distinguish between home-made beet sugar and the imported sugar. There were times when we were using in this country a large portion of sugar coming from Europe and made from beets. This sugar readily went into consumption without question or differential in price.

In many of our new factories it is evident that first attempts are more crude than those executed after longer experience. Usually the factories begin with but few experts. The industry has expanded rapidly, and our supply of experts has been small compared with the demand. Until the machinery of such factories shall be fully adapted to accomplishing the best results and the laborers acquire efficiency in the performance of their duties it is evident that the best quality of sugar will not be placed on the market. It is also evident, as a rule, that the public is easily prepared to believe statements detrimental to a new article as compared with one to which they have long been accustomed. From both of these causes grew the criticisms on beet sugar. I think they should have been limited to the poorer productions of the home product. After its first campaign, at most, any beet-sugar factory is able to produce sugar equal in quality to any other sugar, whatever may be its source. Many of our beet-sugar factories accomplish this immediately. As a result of this popular notion home-made beet sugar has been sold at a price somewhat lower than that of other imported and refined sugar. It has been the custom for the sugar factories to offer to dealers a differential of 10 cents per hundredweight less than that of the regular refined sugar. When local factories sold their sugar to dealers at $4.50 per hundredweight wholesale this differential amounted to about $2\frac{2}{9}$ per cent of that price and a considerably greater per cent on the actual cost of production.

THINNING AND WEEDING BEETS, NEAR AMES, NEBR.

This alone would make a good beginning for a profit account, and, based on the actual cost of production, it would be equal to at least one-third of a 10 per cent dividend. This places home producers of sugar at quite a disadvantage. The attitude of the public is materially changing on this question of quality of beet sugar, and I think it is not far in the future when home producers will be able to demand a price for their product equal to any other. They are aware now that there is no reason why they should not; it is simply a concession to public opinion and at the same time an unfair discount on a proper value of their sugar.

IMPROVEMENT IN FACTORY AND FARM CONDITIONS.

Throughout the last ten years the cost of producing beet sugar has been steadily lowered. The main thing to be kept in view in working for the future progress of the beet-sugar industry in the United States is the possibility of reducing this cost. This possibility depends on so many contingencies that the evolution must of necessity be slow. We have now 45 factories. We have passed the experimental period and have entered that of actual production.

LABOR.

Contributing to the solution of the difficulties and obstacles met by the manufacturer of sugar is the noticeable improvement of labor in the factories. Factories in operation are training schools to be drawn upon by new factories. More scientifically educated young men are drawn toward this industry. Other vocations of life do not offer young men such good opportunities. Here is a great industry, practically in its infancy, with immense future possibilities. Our young men are studying the needs of this industry and equipping themselves to meet them.

One of the first questions raised as offering an obstacle to the introduction of this industry was the lack of sufficient labor qualified to do the kind of work required in beet production on the farm. Our farmers were not accustomed, inured, or disposed as a rule to perform the hard, laborious duties required in growing sugar beets. Indeed, this was a serious obstacle. Yet as new factories have been built and the demand for this kind of labor has increased, our cities and towns, with their supply of foreign element experienced in this work, and our villages, with their young people anxious to secure some kind of employment during the vacation from the public schools, have been equal to this demand. Our own resources for laborers have been largely augmented by new supplies of immigrants, influenced by their friends to come to this country and engage in this kind of work. Our own laborers have gradually accustomed themselves to beet-sugar production and we seem eminently equipped to meet all the demands for labor. The labor supply appears to be growing faster than the demand.

TONNAGE.

We have made a marked improvement in the tonnage and the cost of production of sugar beets. This is one of the features wherein large possibilities exist for lowering the cost of producing sugar. I have noticed that the first attempts of farmers in producing a crop of beets do not, as a usual thing, produce very encouraging results; but in interviewing the farmers during the last year, in watching the comments of local papers as to results accomplished, and in observing the popular feeling generally among the growers, I find that the farmers are coming more and more to look upon sugar beets as a staple crop, and one upon which they can rely most safely under all conditions and circumstances one year after another. This changed feeling has been brought about by a generally higher tonnage, which is the measure of the farmer's returns. Experience with the crop year after year intrenches it more firmly in public estimation. It is quite common in conversation with farmers to hear them say: "I produced so many tons per acre this year, but I know I can do much better than that next year, because I have learned considerable about it." Others say, after producing the crop three or four years: "I first considered that I could not afford to grow beets; now I consider that I can not afford to abandon them." Familiarity with growing sugar beets not only results in a more regular and a higher tonnage, but in a lower cost of production per acre.

EXTRACTION.

Another thing that is very noticeable is that our sugar factories are gradually securing more and more of the sugar contained in the beets. Comparing the results accomplished by the same factories throughout a period of six years makes this very apparent. Extraction is one of the first things that an expert will look into when studying the results accomplished by any particular factory. Most of the contracts made with farmers specify that beets shall have at least 12 per cent of sugar and a purity coefficient of 80. The early results in growing sugar beets indicated that our average would not be much above this minimum requirement, but more recent results show that the average sugar content and purity are increasing, and that they will be higher than the averages obtained in Germany, France, and the other sugar-producing countries of Europe, after all their years of experience. The average of the sugar contents of the beets worked by all the factories throughout the United States last year was 14.8 per cent, and the average purity coefficient was 82.2. It is possible, with beets possessing the minimum requirements (12 and 80), to secure in refined sugar an extraction of 10 per cent of the original weight of the beets. My first investigations among the factories revealed the fact that this was thought to be about the future average extraction of the United States. This means that

an amount of sugar equal to 2 per cent of the weight of the beets is lost in the cossettes and molasses. Throughout the arid portions of the country there seems to be no great difficulty in maintaining a sugar content in the beets averaging through the entire campaign 16½ to 17 per cent; many of the beets run over 20 per cent. Now it is evident that the higher the sugar content is the more the farmer and the factory will realize from a ton of beets. If they work up beets with higher sugar content, the factories can afford to pay more per ton for them, the same as a smelter can afford to pay more for high-grade than for low-grade ore. The factory can extract the sugar from a ton of high-grade beets much more cheaply and can secure a larger proportion of the sugar. The tendency toward higher extraction is one of the best indications of improved conditions.

It has been shown that considerable sugar passes off with the cossettes or remains in the molasses. The molasses is worked and operated upon in different ways to secure the sugar it contains. When it is finally disposed of as a waste product it usually contains about 49 to 50 per cent sugar, the rest of its composition being made up of water and various kinds of salts and other impurities that originally existed in the beets or were introduced in the juice, such as lime, or were held in solution in the water entering into the process of manufacture. To obtain the sugar held in this final molasses is the ever-recurring problem of the sugar factory. Every superintendent is carefully studying all the devices for securing a more complete extraction of the sugar. Some of the older factories are installing special processes for carrying this extraction to the farthest limit. The new factories being built are quite generally installing these processes in the beginning. Several methods are used. In some factories only one of these processes is in use; in others all of them are put in operation. The leading processes are (1) crystallization in motion, (2) osmose, and (3) Steffin's. It is apparent that these additional efforts increase the expense. To secure the same amount of sugar from the molasses costs more than to extract it from the juice. The factory can afford to carry the process to the point where the cost of securing the sugar equals the value of the sugar extracted, but no further. All our factories are working toward higher extraction and are obtaining favorable results, gradually lessening the quantity of sugar left in the molasses and the cost of securing the sugar from it.

USES OF BY-PRODUCTS.

As the uses and value of pulp as a food for stock are discussed at length in another part of this report, it need only be mentioned here as the most important by-product of the beet-sugar factory.

The molasses is a by-product of considerable utility, but not so important as the pulp. Originally it was an actual obstacle in the way

of the factory, requiring some expense to remove. It is now receiving attention from various sources to discover in what manner it can be most practically and profitably utilized. In the older countries they use it as a raw product in the manufacture of vinegar, alcohol, shoe blacking, and fertilizer. Different factories make different uses of the molasses. The most practical and profitable use of it at present is in making alcohol. A chemical company in Bay City, Mich., is arranging to handle large quantities of this molasses in the manufacture of alcohol. It is claimed that the alcohol produced from it is superior in quality to that ordinarily found in the markets. This company is contracting with several factories in Michigan and other States to use their entire output of molasses, and it is said that other companies are forming, some with a view to working up this product in the manufacture of alcohol, and others for manufacturing vinegar from it.

METHODS OF CULTIVATION.

Improvements in methods of cultivation and knowledge of correct principles of agriculture are important results from the establishment of the beet-sugar industry. The science of meteorology is probably founded mainly on the results of actual observations. Certain effects have been observed to follow certain phenomena. A long record of such occurrences makes it possible to establish rules upon which many of the predictions of the Weather Bureau are based. The longer the period of observation the more certain become its predictions. This illustrates the manner in which we are accumulating facts with reference to beet culture. Every farmer is an observer. The sugar-beet crop is practically new, and the cultivation of it is practically one of trial. We are building up a mass of definite accurate information as a result of these trials. We know that sugar beets are a profitable crop in themselves. We know that beet-sugar production contributes benefits to agriculture. We are learning that the thorough cultivation, deep plowing, minute pulverization of the soil, and more nearly complete destruction of weeds add much to the condition of the soil itself. Sugar-beet culture is practically garden culture (Pls. I and II). A sugar-beet crop responds readily to intelligently applied fertilizer; above all it meets the expense of fertilization. A piece of land is brought into a much better condition for all kinds of crops after it has been used for a period in growing sugar beets. The crop naturally leads a farmer to the habit of more intense cultivation because the results are so apparent. He appreciates more the rewards of laborious effort intelligently applied. He rotates sugar beets with other crops and finally brings his farm to a high state of cultivation and learns their value in comparison with other crops.

SUGAR-BEET PULP AS ANIMAL FOOD.

Since early attempts in agriculture during the first settlement of the country few things have occurred of so much vital importance to the agricultural interests as the installation of the beet-sugar industry.

The advancement of modern science and its application to the development of the industries of the country is one of the marked features of our short history. Agriculture was slow in securing the benefits of scientific discoveries, but recently there has been a great general awakening in all the branches of agriculture. It is attracting the best thought of the chemist, physicist, the manufacturer, and financier. To-day the agricultural resources are strongly and favorably competing with all other branches of industry for capital to finance its various enterprises. There is no question but that the scientist, the financier, and the press are in advance of the farmer in appreciating the financial benefits of the sugar industry to all agricultural interests.

The farmer has a twofold interest in the development of the beet-sugar industry, both in his own section and in general throughout the United States: First, it calls for an immense amount of capital, labor, and raw materials of many kinds, and thus creates a demand for every kind of product that is grown on the farm; second, it supplies the farmer a cheap and valuable stock food.

WHAT IS SUGAR-BEET PULP?

Sugar-beet pulp is the residuum left after extracting the sugar from the beet. It is to the sugar beet what oil cake and oil meal are to the flaxseed. It is a by-product of the factory, the same as brewers' grains is a by-product of the brewery, or gluten feeds of the starch factory. The oil cake and oil meal, and the by-products of the brewery, the distillery, and the starch factory all have a commercial value as feeds for stock; but I wish to call attention to the advantages possessed by sugar-beet pulp. In the first place, the breweries, distilleries, starch factories, and linseed-oil mills are all located at manufacturing centers, and far distant from most of the farmers, and for this reason their by-products are not generally known by farmers and feeders. The raw material that these factories use, such as flaxseed and grains of various kinds, are shipped by rail from considerable distances for the purpose of being worked up. But the sugar factory must be built in the midst of the area which supplies it with raw material; for this reason the supply of pulp is immediately available at little expense to the farmer, it being possible in most instances for the farmer to deliver to the factory a load of beets and take home with him a load of pulp; or, if he lives at some distance and his pulp must be delivered by the carload lot, he has a short freight haul which does not add very materially to the expense.

In 1901 we imported from foreign countries sugar to the valuation of $122,000,000; the wholesalers paid about $159,000,000 for it after it was refined; the people actually paid for this imported sugar when it went into consumption about $196,000,000. It is safe to say that

for imported sugar and home-made product the people paid about $225,000,000. Several countries[a] in Europe have developed large interests in beet-sugar production, and, partly to supply the demand for sugar in this country, some of them sufficient to furnish at least two-thirds of our consumption. In doing this they have become large producers of sugar-beet pulp, and for a long time they have had to give considerable attention to the question of feeding it.

In Germany, France, Austria-Hungary, and Russia pulp as an article of commerce is as staple as corn, oats, barley, rye, or hay in this country. There is nearly as much written about it in the agricultural press of those countries as there is about the sugar itself. If it should be eliminated or the supply cut off for some reason, the feeding and dairy interests of those countries would be seriously affected. If, after the farming community around each factory has supplied its needs, there is a surplus of pulp, it is put through a drying process and placed on the markets for general consumption. Pressed pulp, like turnips, mangel-wurzels, rutabagas, and sugar beets themselves, is a very succulent food, containing about 85 per cent of water. After going through this drying process it comes out thoroughly dry, in flakes, the water content being reduced to about 5 per cent of the whole. Dried pulp as a food is, therefore, a great deal richer in nutritious elements, pound for pound, than the original pressed pulp. This drying of pulp makes it possible to preserve it for a long time and to ship it long distances at a minimum of expense. In the countries mentioned dried pulp is sold at the feed stores the same as bran and oil cake in our own country, and almost every person owning an animal, whether living in the country or in a village or town, is a consumer of pulp.

Unfortunately our people are not experienced in the use of pulp. As a result, some of our factories are unable to dispose of their supply and many of them dispose of it for a very small consideration. Some factories are compelled to give it away or dump it out on some available waste spot or into bayous or rivers, using any practical method to get it out of their way. This is the present status in regard to disposal of pulp in this country. The time is coming when this pulp will gradually win its way into favor and become one of the staple articles of commerce. The farmers around our sugar factories will see the opportunity it affords for rearing animals of all kinds and its availability for supporting creameries and dairies, and whatever surplus pulp remains over at any particular factory will be dried and put on the general market.

To illustrate how much knowledge and experience has to do with the demand for any article of public utility I will cite the experience of the factories in New York. The farmer of this State had been

[a] All European countries produce sufficient sugar to meet their own consumption except England, Portugal, Greece, Switzerland, and Turkey.

schooled for years in intensive agriculture. In competition with the Western farmer he found the necessity of feeding his crops and putting on the market such products as meats, poultry, eggs, butter, and the like. He was accustomed to feeding the by-products of the distillery, the starch factory, and the brewery, and when the sugar factories were installed he naturally took to pulp feeding as a matter of course, and the factories in that State were able to dispose of their pulp immediately at $1 a ton. A similar experience, and for the same reason, was had in Wisconsin. In Michigan the lumber interests had been very extensive and agriculture was in a somewhat backward state of development. The sugar factories were installed so rapidly and in such numbers that no profitable disposition could be made of the pulp. It was sold at a very low figure, given away, or thrown away. These Michigan companies have found that they will have to wait patiently until the people of the State become better acquainted with the use and benefits of pulp feeding. And this is taking place surely if not rapidly. Farmers are beginning to utilize pulp, and the factories are able to dispose of more at some price; and now we hear on every hand of new feeding and creamery enterprises stimulated by this useful article of food.

I desire in this connection to correct a common error that seems to have gotten into the minds of the people generally who have no acquaintance with pulp. Many seem to think that beets are boiled or ground and pressed in the process of sugar extraction. This is not true. The raw beet is simply cut into long, slender, grooved slices. In the factory these slices are known as cossettes. The cossettes are placed in large steel air-tight cylindrical vats and immersed in hot water, which is under pressure, but not in such a way as to crush the cossettes. Fourteen applications of hot water are made in this way to the same lot of cossettes, and in this manner the sugar is dissolved out of the beets and carried off in the water when it is drawn off. This watery solution of sugar and the salts extracted from the beets is evaporated in the sugar factory, and the cossettes themselves come out practically in the same form they went in. They are conducted out by carriers, put under a certain amount of pressure, and are then ready to be placed in the pulp silo or to be taken away for feeding. Where pressure is applied, as just indicated, the product is known as pressed pulp. If not pressed the pulp will retain a higher percentage of water.

SUGAR BEETS, BEET LEAVES, AND BEET PULP COMPARED FOR FEEDING QUALITIES.

Sugar beets are extensively grown in all European countries, along with other root crops for feeding purposes. The experiment stations throughout the United States have given considerable attention to the

growing of this crop strictly for stock food. The Iowa State Experiment Station, located at Ames, found that from 25 to 28 tons of sugar beets per acre could be grown, and even more in some instances. The beets were also found to be a very desirable stock food. It does not require nearly so much labor and expense to grow an acre of beets for stock as it does to grow an acre of beets intended for the sugar factory. In order to grow beets for factory purposes certain results must be obtained in the constituent elements of the beets. In the first place, they must be high in sugar and low in certain salts, known as impurities. Everything depends upon the quality and purity of the beets so far as their usefulness to the sugar manufacturer is concerned.

These qualities are not required in the case of the larger or stock beets. It is found that sugar beets must be held down to a certain maximum in weight in order to get the quality and purity. This is not true of the stock beets; hence, the farmer can produce considerably higher tonnage when growing simply for stock. Sugar beets are a profitable crop to raise for feeding along with grains and other stronger foods. By experience any farmer realizes at once the value, quality, and cheapness of sugar beets grown for stock. I have constantly urged this point throughout my reports on progress of the beet-sugar industry. The farmer not only realizes the advantages of raising a crop of beets, but he also becomes more familiar with the habits of the plant and the general nature of the crop itself. I have urged that a general production of sugar beets for stock purposes would be beneficial to any community, and where a factory is liable to be established such production tends to educate the community in regard to the germination, cultivation, and harvesting of the crop. In such case the factory is not required to begin, as is usual, with everybody in ignorance of the requirements.

I wish to insist on the desirability of raising sugar beets for stock food under any circumstances, but of course there is less necessity for growing sugar beets for stock in a locality where a sugar factory is in operation. Sugar beets and sugar-beet pulp have about the same value, ton for ton, for feeding purposes. The farmer who takes a ton of beets to the factory and brings back a ton of pulp has really brought back about as much feeding value as was in the beets he delivered; and, while he obtains only one half as many tons of pulp as he delivers tons of beets to the factory, it only costs him about one-fifth to one-third of what it would cost to grow the beets producing the pulp. When he delivers beets to the factory and takes home the pulp, he has left most of the sugar and considerable of the water and salts which the beets contained at the factory, the bulk of the original elements making up the feeding qualities of the beets being still in the pulp. Sugar is not to be classed as one of the valuable feeding qualities of the beet. Sugar is made up of oxygen, hydrogen, and carbon, or, as a famous

chemist used to express it, "The sugar in the beet is composed of air, sunshine, and water." Practically the sugar in the beet comes from the air, while the main feeding qualities of the beet come from the soil. Thus the farmer can readily see that, if there is a sugar factory where he can get pulp, it is much cheaper and better in every way to procure pulp than to grow sugar beets for feeding purposes. He can grow beets and sell the sugar out of them to the factory, and still have left the greater part of the feeding qualities of the original beets at a comparatively small cost. This, then, should be the rule: The farmer who is not near a sugar factory should grow sugar beets for stock food, because they are a cheap, valuable, and healthful food for animals; the farmer who lives in the locality of a sugar factory should grow beets for the factory, and use the pulp from the factory for feeding purposes.

Beet leaves are also used extensively for stock food in European countries and in sections of this country where we have beet-sugar factories. It is probable that beet leaves make a better food than either sugar beets or beet pulp. In harvesting the beets the leaves with a part of the crown are clipped off by a stroke of the knife and allowed to fall in piles or windrows in the fields, where they are cured by the action of the air and sun, the same as hay. They are then hauled out and fed or put up in mows like hay. In European countries they are especially prepared by a process known as drying, the same as with pulp, which is accomplished in kilns, and the dried leaves are sold in the markets for stock food. I have conversed with a great many farmers and scientists on this subject of using the leaves for feeding purposes, and, while nothing can be said other than favorable as to the quality of beet leaves for stock food, whether cured like hay or dried and put on the market, yet it is an open question whether or not they should be so used. In performing their function in the growth of the beet they store up considerable valuable fertilizer, and if left on the ground increase the humus and contribute materially to the fertility of the soil. It is clear that if the leaves are taken off the ground its fertility must be kept up to an equal extent by using some thing else to supply the deficiency. This entails expense and labor. It is simply a question of whether the leaves will accomplish more for feeding or for fertility. The consensus of opinion among the people I have consulted on the subject appears to be that it is better to let the leaves remain on the ground until such time as all barnyard fertilizers are utilized.

I presume it has occurred to the practical farmer in reading this discussion that the growing of sugar beets for whatever purpose stimulates an increase of animals on his farm, and offers him an opportunity to keep up the fertility of his soil. It is a common observation in many places throughout the United States that much of the farming

is accomplished without the proper balance between the animal and the crop side. For instance, take the small-grain sections. We are always confronted with the idea that we can not go on forever removing these crops from the fields, leaving practically nothing to restore the fertility of the soil. The farmers in such sections do not keep sufficient stock to furnish enough barnyard manure to keep up the fertility of the soil. Sugar beets, whether raised for stock or for the factory, improve the conditions. They enable the farmer to grow grain and at the same time encourage him to support a large number of animals, which in turn are giving him back in barnyard manure the elements of soil fertility. He raises a crop and sells the sugar to the factory, feeds the nutritive portion of his crop to his stock, sells his stock at a profit, and returns to his land in the manure the fertility taken from the soil by the crop.

KINDS OF PULP.

In connection with pulp feeding, it is necessary to discuss the kinds of pulp. We have fresh (unpressed) pulp, pressed pulp, siloed pulp, and mechanically dried pulp. Fresh pulp is that directly from the diffusion battery, containing from 90 to 94 per cent of water. Pressed pulp is that which has been run through a press which removes a portion of the moisture; it contains from 85 to 90 per cent of water. Siloed pulp, or old pulp, is that which has been held over and in which certain changes have taken place; that is to say, it has soured, and corresponds somewhat to ensilage. Dried pulp is produced by taking the pressed pulp and running it into kilns or cylinders, where it is subjected to a high degree of heat while being constantly agitated. It comes out in a very flaky dry state, containing only about 5 per cent of water.

The question naturally arises, What kind of pulp is the best to feed? This is entirely dependent upon circumstances. If you are a farmer in the vicinity of a sugar factory, in all cases and by all means use the pressed pulp. If you are a farmer at a distance from the factory or living in a village or city, the best kind of pulp for you to use is the dried product. I shall aim to show further along that there are certain mechanical reasons why the pressed pulp is best under the same conditions and advantages for using either. A person living at a distance from the factory can not afford to pay for the transportation of so much water as is contained in pulp fresh from the factory.

The fresh pulp and the fresh pressed pulp are very much alike in composition, the main difference being that the pressed pulp contains from 5 to 10 per cent less water. Both have the advantage of succulency, but it has been found by experience that the fresh pulp is too moist. As the pressed pulp contains less water, it is correspondingly more valuable as food for stock. Pressed pulp is therefore to be preferred and most factories are prepared to furnish it.

Some factories being unable to dispose of the pulp, have to resort to the cheapest method of getting it out of the way. In such instances it is often floated out with water to the place of its destination and not required to pass through the presses at all. Other factories convey the pulp directly from the diffusion batteries to the cars or other receptacles, not pressing it, but allowing it to drain. Such pulp contains considerably more water than that passing through the presses.

If fresh pulp contains 90 per cent of water (which is the minimum), a ton of it will contain 200 pounds of dry matter. If ordinary pressed pulp contains 85 per cent of water, a ton of it will contain 300 pounds of dry matter. In Germany they are able to apply a pressure that furnishes a pressed pulp containing only 80 per cent of water; such pulp would furnish 400 pounds of dry matter per ton. It is evident that the farmer should prefer to buy pressed pulp. In Germany where the factories are able to dispose of their dried pulp they receive for the same $1 per hundredweight, or $22.40 per ton. It is apparent that the value of this dried pulp is due to the very large proportion of dry matter it contains. Such pulp is preferable on account of its condensed form for shipment to a distance, and this widens its market. It is valuable to the extent of the nutriment it contains, but loses some of the advantage possessed by the fresh pulp in its mechanical and sanitary effects.

BENEFITS OF FEEDING PULP.

The feeding industry of the United States has grown up, like many other things, on the principle of giving the most attention to quantity rather than quality, trying to accomplish the most with the least effort. In coming in competition with foreign-fed meats, such as mutton and beef, especially from England and Scotland, our feeders realize that in order to place the American meats, butter, and cheese on the tables of the foreigners, they must not only produce quantity at low cost, but must also produce quality. It was the discovery of this fact that led our intelligent successful feeders to investigate the cause contributing the fine quality and flavor of the English and Scotch beef and mutton. We were capable practically of supplying the needs of the world with meats, but, though there were exceptions, feeders as a class had not reached that high degree of excellence in quality and flavor obtained in those countries.

In meat production it was found that England and Scotland fed, along with their dry forage and grain, considerable succulent feed, such as turnips, mangel-wurzels, sugar beets, and rape. This induced the agricultural experiment stations throughout the United States to begin series of feeding experiments, using rations composed of ordinary dry feeds and succulent matter. They have published to the

world the results obtained, with the effect of greatly modifying our whole system of feeding for meat production. A food ration is recommended containing a good supply of these succulent feeds as absolutely necessary to a high degree of excellency in a steak, chop, or roast. We are able to supply even the English not only large quantities of meat, but large quantities of the best meat, competing with her choicest production. We are able to compete with the best meat-producing districts of England and Scotland by feeding rape, sugar beets, mangel-wurzels, and other succulent crops with our concentrated feeds, our cereals, and dry forage.

Sugar beets and pulp offer to every feeder of sheep, cattle, horses, hogs, or milch cows a useful succulent feed for stock rations producing this high quality of animal product, as has been shown through these tests.

I have tried to set forth clearly and distinctly the results to be accomplished in feeding pressed pulp. The question naturally arises, "Are these results obtained on account of the nutritious qualities of the pulp alone?" I will have to answer, "No. Sugar-beet pulp is not valuable solely on account of the nutrients it contains, though in this respect it is directly comparable with coarse fodders. The animal could not be fattened on pulp alone; indeed, it is doubtful whether it could be successfully reared or sustained for a considerable length of time. It is found that the benefits of pulp feeding result largely from its mechanical and sanitary effects." Our feeds have consisted largely of the cereals and dry forage; the addition of this pulp to the ration appears to aid materially the digestion of the other foods. I have often asked men who are extensive feeders of pulp, "What is the comparative commercial value of pulp?" I have always been informed in reply to this question that "no chemical analysis can give the value of sugar-beet pulp. Its value does not result so much from its nutritive qualities as from its aid to digestion and the general healthful tone which it gives the animal itself. We practically feed as much of grains and other forage in a ration as we would without pulp; gains are not accomplished on the saving of grain in a daily ration, but they are accomplished in the rapidity with which the animal takes on flesh and gains in weight, cutting down the total requirement."

Mr. John Remers, of Grand Island, Nebr., who has been a large feeder of steers for years, puts it this way: "I feed about as much grain and hay with the pulp ration as I did without, but I put them on the market in three-fourths of the time." He called my attention, in walking through his feed yards, to the entire absence of grain and other feed in the droppings in the barnyard, showing that the animals were completely digesting what was fed. I give it as the general verdict of feeders that the benefits of pulp result from the more nearly complete digestion and assimilation of the nutrients in the ration; and

that the superior quality of the meat itself comes through the healthful tone of the organs of the animal, which are able to perform their work evenly and perfectly, and therefore produce superior meat.

HOW TO FEED PULP.

It is found that in fattening any kind of an animal where pulp enters into the ration, a full supply of pulp should not be furnished immediately; the animal must be allowed to adjust itself to the new food. The best practice in all cases of fattening is to begin on a small amount of pulp, say 40 pounds per day for a steer, and gradually work up to 80 pounds per day, and then gradually work down again to 40, giving the animal a chance to "finish" or to harden in flesh. Milch cows may be gradually worked up from 20 to 40 or 50 pounds per day, and this amount kept regularly in their diet. Fattening lambs or sheep are put on from 1 to 2 pounds and gradually worked up to 7 or 8, gradually diminishing to the minimum with the "finish." Mr. Remers claims that he can put all kinds of stock on their full feed with pulp quicker and that they will eat damaged roughness better with pulp than in any other way. The tendency of pulp is to act as a laxative; it is lacking in ash and has a large quantity of water, so that the digestive apparatus of the animal must be allowed to adjust itself to the new food.

Mr. Allen, secretary of the Standard Cattle Company, probably one of the largest cattle and sheep-feeding concerns in the country, has had considerable experience in feeding pressed pulp. Near his feed yards is a large beet-sugar factory, capable of working up 500 tons of beets per day, and producing about 250 tons of pulp. He fed last year about 33,000 head of sheep. I examined the flock at the time he purchased them, in company with one of the best sheep experts in the United States, who pronounced them an ordinary flock. They were given the regular ration of grain and hay, and in addition pulp. When they were sold he topped the market with this bunch, or the most of them. This indicates that it is possible to take an ordinary flock of sheep and make out of them the best marketable meat, a product that would compete with the English mutton. Mr. Allen fed a large bunch of sheep the year before, and in this connection I quote his feeder as to how and what he fed them:

> The pulp is the usual diffusion pulp, loaded when fresh onto the cars at the factory and used immediately.
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> The surplus pulp produced by the factory over what we could use was unloaded from the cars at convenient points on the railroad into large piles alongside the track and thus left until used. About 10 to 12 inches of the outside of the pile decayed and formed a dense mass which made a silo for the remainder, keeping it in very good condition. We are now using pulp that has been kept in this way for about two months, and it is all right.
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> The pulp is fed in troughs similar to the troughs ordinarily used in sheep feeding, but somewhat deeper, so as to hold the amount of pulp necessary. The pulp is first

scattered in the troughs and the grain scattered on top of it; afterwards they are mixed thoroughly. The sheep are fed twice daily.

We commenced feeding pulp by giving 1 pound per head per day and mixing this with a grain ration which at that time amounted to 0.9 pound for lambs and 1.1 pounds for sheep. We gradually increased the pulp ration until it reached between 9 and 10 pounds per head per day for sheep, and between 7 and 8 pounds per head for lambs, which was about all they would eat.

As to the value of pulp as compared with other feed, I have no accurate data. I think it requires less time to fatten and consequently less grain. In this way on a full ration, such as would be used without pulp, I believe sheep will fatten in considerably less time, which will result in a decrease in the amount of grain used, and I also think that a heavy grain ration can be fed with greater safety when using pulp.

We have not experimented. On December 12, 1899, we put somewhat over 16,000 sheep into our barns and fed them on a ration of ensilage and grain with plenty of hay until the factory provided us with pulp, which was about the 10th of January. We then commenced using the pulp as herein stated and have had very satisfactory results.

In feeding pulp a liberal supply of salt should be used, as the results are always shown to be beneficial.

SCIENTIFIC EXPERIMENTS IN PULP FEEDING.

In seeking for actual facts as to the feeding value of any particular article entering into the food ration of stock, especially if it be a new and untried one, we naturally turn to the State experiment stations for their conclusions. These stations are the high court of appeal on all mooted questions in agriculture. They are undoubtedly one of the most beneficent of all the helpful things the National Government has devised to foster and develop agriculture in this country. I will present the results of work done by the experiment stations of three States—Colorado, Michigan, and New York. Colorado and Michigan have developed considerable interest in beet sugar and at the same time are beginning a healthful improvement of their stock interests. New York is becoming interested in a less degree in sugar production from beets, but the State has a great interest in stock feeding and dairying.

EXPERIMENTS IN MICHIGAN.[a]

I will first consider the results of work at the experiment station in Michigan, under the directorship of Prof. Clinton D. Smith. He recently concluded two experiments in feeding pulp, in which the objects of the feeding were for different purposes. Below I summarize his report on the same:

The first was an experiment conducted on the farm of the Hon. A. W. Wright, near Alma, Mich. He had several hundred head of steers, thin in flesh; he had plenty of cheap pasture for grazing in the summer; his object was to carry the cattle through with as little outlay as possible until his pasture was available; he had plenty of other

[a] Bul. 193, Michigan Expt. Station.

feed, but it was not of the best quality; he had barns and sheds and furnished all the feed necessary for the experiment, which was conducted under the direction of the State experiment station. The steers used in the experiments were divided into two lots as much alike as possible. The first lot was fed a daily ration made up as follows: Pulp, 55 pounds; mixed hay, 8.5 pounds; shredded corn stover, 4 pounds; ground grain, 2.4 pounds. The daily ration of the second lot was: Mixed hay, 11.5 pounds; shredded corn stover, 8 pounds; grain, 11.5 pounds. It will be noticed that the second lot was fed only grain and ordinary forage, while the first lot was fed the same and in addition sugar-beet pulp. The results were as follows: The lot of steers receiving pulp in their daily ration made an average daily gain of 1.42 pounds. The lot receiving no pulp made an average daily gain of 0.684 pound. Director Smith in his report on this experiment says:

> Comparing the amount of food consumed by each pen to produce the net pounds gained and computing from this data the value of a ton of pulp as an additional succulent fodder, the tests show that under the conditions existing a ton of pulp fed with other factors in the ration took the place of 421.5 pounds of corn stover, 274 pounds of mixed hay, and 68.8 pounds of grain.

He calls attention to the fact that the grain and forage fed to these two lots of cattle were not of the best quality, and, while the pulp-fed steers made remarkable gains over the others, it must not be taken as absolutely proven that this would have happened had the food ration of the second lot been of the best quality. He also calls attention to the rule of scientific experimenters that the result of no single experiment must be taken as establishing definite facts; such experiments should be repeated before accepting the results as conclusive.

The station conducted a second feeding experiment on the farm of the Hon. A. M. Todd, of western Michigan, who had a large number of steers in poor condition. It was the purpose of this experiment to fatten as rapidly as possible. The station supervised the feeding in this instance as in the other. The steers entering into the experiment were divided into two lots as nearly equal as possible. The first lot received a poor quality of mixed hay and in addition wheat bran, oats, and corn meal. The second lot received the same ration and in addition beet pulp. The results of the experiment were as follows: The first lot receiving no pulp made a daily gain of 1.84 pounds. The second lot, to which pulp was fed, made a daily gain of 2.25 pounds. In order to establish a ratio of comparative values between pulp and the other items of food which entered into the ration used, I give below the results as determined by Director Smith:

> Making the computations as before to find the estimated value of a ton of pulp, we find that under the existing conditions at Pearl (Todd's farm) a ton of pulp took the place of 244 pounds of mixed hay, 32.6 pounds of wheat bran, 296 pounds of corn meal, and 27.2 pounds of oats.

A third experiment was conducted also on the farm of Mr. Todd, in which two lots of steers were fed the same kind and amount of dry feed for six weeks. To the ration of the one lot pulp was added. The feeding of 13,775 pounds of pulp gave an aggregate increase gain to the steers so fed of 280 pounds. Counting the beef worth 5 cents per pound, it gave the pulp the value of $2.03 per ton.

EXPERIMENTS IN COLORADO.[a]

This State has become intensely interested in beet-sugar production, and is also building up considerable interest in lamb and general stock production. The experiment station located at Fort Collins, under the directorship of Prof. L. G. Carpenter, has been conducting feeding experiments with sugar-beet pulp. Without going into the details of the experiments themselves, I give some of the results obtained as set forth in the report of the director. It was demonstrated that sugar beets and sugar-beet pulp were equally valuable for feeding pigs. Pulp may be very profitably fed to growing pigs in connection with the grain ration. The value of the pulp, measured by the results of the experiments, indicates that pulp costing $1.50 per ton may be fed to good profit. Satisfactory results were secured when pulp was fed in combination with grain. Pulp served the same purpose in a hog ration as did sugar beets and at less expense. It is not advisable to feed more than 2 pounds of pulp in weight. The experiments indicate that hogs derive some nutrition from beets or pulp, but the principal use seems to be mechanical. Beet pulp is a valuable roughage for lambs fed with alfalfa; pulp-fed mutton has good flavor. Pulp fed with alfalfa made gains at the least cost per pound and gave the largest profit. The second best profit was from lambs which were fed with spelt and alfalfa. The third best combination was beets and alfalfa with a ration of grain, gradually decreasing the amount of beets in the ration toward the end of the feeding period. Pulp should be gradually diminished during the finishing period. Sugar beets were not as valuable as pulp for lambs.

EXPERIMENTS IN NEW YORK.[b]

The experiment station at Cornell, N. Y., conducted an experiment in order to ascertain the nutritive value of the dry matter in pulp in comparison with the dry matter in corn silage. It was found that they were equal. To furnish the same amount of dry matter it took twice the quantity of pulp as of the silage.

While it must be conceded that we should not base positive conclusions on a single set of experiments, here are several sets of experiments, conducted at different experiment stations, all giving strong

[a] Bul. 74, Colorado Expt. Station.

[b] Bul. 183, New York (Cornell) Expt. Station.

evidence on the one point, namely, that sugar-beet pulp is a desirable, cheap, and valuable food for stock of all kinds.

INFLUENCE OF PULP FEEDING ON LIVE STOCK AND DAIRY INDUSTRIES.

I presume it is patent to the reader of this article on pulp, in the light of the experience of European countries and the tendency shown in our own limited development of the industry, that pulp feeding will have a remarkably stimulating influence on the agricultural interests generally. In the States of the Rocky Mountain region and the Pacific coast, live-stock industries have been greatly stimulated by the production of alfalfa and the use of sugar-beet pulp from the sugar factories of these States. In all these States where the beet-sugar industry has taken hold, active development of the dairy industry may be observed. Colorado, Utah, and California will soon be contributing to the general consumption considerable dairy-products, in addition to supplying their own demands. Wisconsin is already one of the leading dairy States of the Union. There is a sugar factory in that State at Menominee Falls, and a prospect for three or four being in operation in other parts of the State in 1903, while at a dozen other places active steps are being taken for the installation of factories no later than 1904. The large dairy interests of Wisconsin will find in these sugar factories their strongest allies in producing the best and cheapest product. In Michigan we have the reverse of these conditions. This State has a large number of sugar factories already in operation and is beginning to establish dairy interests which should grow rapidly under the stimulus of the sugar factory by-product.

PRESENT PULP POSSIBILITIES.

In pursuance of the claims made for pulp as a food for animals, I will introduce an estimate of the pulp product[a] of the United States and the number of animals which might be fed thereon. In this estimate I shall use the three States having the largest interest in the manufacture of sugar from beets, and close with the total production of pulp in the United States. I shall use as factors in this estimate the combined daily capacity of the factories now in existence, the average length of campaign (eighty-eight days) which the factories operated through the United States in 1901, the pulp to be fed in a balanced ration along with other feeds, 50 pounds of pulp to be fed daily to each milch cow during the entire year, an average of 50

[a] The figures given in this estimate are much higher than the actual production, owing to the fact that scarcely any of the factories have ever been able to work to their full capacity because of short supplies of beets. The quantity of beets actually worked by all the factories in 1901 was 1,685,688 tons, being about half the present estimate.

pounds of pulp daily to each steer during the fattening season of six months, and an average of 5 pounds to each sheep or lamb during the fattening season.

Michigan would produce 1,100,000 tons of beets, which would yield 550,000 tons of pulp. This pulp would feed 60,280 milch cows, or 120,560 steers, or 1,205,600 sheep.

California would produce 928,400 tons of beets, or 464,200 tons of pulp. This pulp would feed 50,223 milch cows, or 100,466 steers, or 1,000,000 sheep.

Colorado would produce 391,600 tons of beets, or 195,800 tons of pulp. This would feed 21,459 milch cows, or 42,918 steers, or 429,180 sheep.

The United States would produce 3,281,040 tons of beets, or 1,640,520 tons of pulp. This would feed 179,798 milch cows, or 359,596 steers, or 3,595,960 sheep.

The Michigan experiment station demonstrated that a ton of pulp would produce 41 pounds of beef, live weight. At this rate the total annual pulp product of the United States would produce 67,261,320 pounds of beef worth, at 5 cents per pound, $3,363,066. Not over 10 per cent of this utility is realized at present.

The disposal of the pulp produced by the beet-sugar factories is a question receiving considerable attention throughout the United States, especially in localities where farmers are not experienced in the use of by-products in their stock rations. The industry is developing so fast, and in some quarters the information with reference to the value of pulp is so limited, that the factories are finding it difficult to make any profitable disposal of this by-product. This affects seriously the earning power of the factories.

In the Colorado experiments already cited it was demonstrated that pulp costing $1.50 per ton can be fed at a profit. If we accept this valuation of pulp, throwing it away means a loss to the factory of 75 cents on each ton of beets worked, or at least 15 per cent of the purchase price. If, as demonstrated in the Michigan experiment cited, the addition of pulp to the ration produced $2.03 worth of beef for every ton of pulp fed, the feeding of pulp costing $1.50 will yield a profit of 33⅓ per cent. The New York experiments demonstrate that two tons of pulp are equal in value to 1 ton of ensilage. The farmer who knows the feeding value of ensilage can draw his own conclusions as to the value of pulp.

In this connection I take from a publication known as the Sugar Beet (Philadelphia) the following report of German experiments:

Sixty pounds of forage beets may be replaced by 10 pounds of dried cossette residuum, with a daily increase of 2 pounds in the milk production. (This is based on the weight of the cattle fed at 1,200 pounds.) On the other hand, for 92 pounds of forage beets was substituted 92 pounds of semifermented beet pulp. The daily milk increase was 3.8 pounds.

Here is another report from the same journal:

At the national convention held in Belgium it was pointed out that 150,000 acres cultivated in beets yielded 2,098,000 tons of beets, which were sold for $9,450,000. The value of the resulting pulp was $1,250,000 (13.45 per cent of price of beets), and was sufficient to feed 300,000 head of cattle.

The manager of a sugar factory who is not able to dispose of his pulp realizes that until he is able to do so his factory is sustaining considerable loss, so that factories of this kind are giving attention to pulp feeding to avert this loss. Some have been trying various devices for producing commercial dried pulp.

A PRACTICAL ILLUSTRATION.

The Standard Cattle Company at Ames, Nebr., after exhaustive experiments with pulp from the factories at Grand Island and Norfolk, at their extensive feeding concern at Ames, Nebr., concluded that its facilities would be very much enhanced if it had a sufficient supply of cheaper pulp than that shipped from such a distance. This led the company to promote the building of a sugar factory, those interested in the cattle company being largely the same as those in the sugar company. This sugar factory is medium in size, having a daily capacity of about 500 tons of beets, the object being to build a factory large enough to supply sufficient pulp for the use of the cattle company. Below I quote Mr. Allen, secretary of the cattle company, and one of the principal interested parties in the sugar company, with reference to the purposes in establishing a sugar factory, and as to general results in feeding the pulp:

It was my purpose in attempting to promote a factory at this point to secure pulp for feeding cattle and sheep for the benefit of the business of our cattle company. This was the initial idea of the whole project, and I confidently expect that our experience in the future will prove that the use of pulp will be of sufficient value to give us an advantage in feeding animals for the food supply as compared with our basis of business for the last fourteen years. In course of time I shall be able to give you our actual experience, which will be valuable. In the feeding of sheep the past winter, we feel very confident that we are on the right track and that our future feeding will be successful. I believe that the use of pulp will enable us to fatten cattle with less grain than it has been our practice to use, or, if we make the cattle eat an equal amount of grain, that they will be fattened within a shorter time. I prefer, however, to make a saving of grain and take a longer time for fattening the cattle, as the valuable results will be more certainly secured by taking plenty of time to do it.

I do not think it useful to attempt to give the value of pulp as compared with other food stuffs. This question is often asked in regard to oil cake, for instance, and it is not possible to answer it. At the present time it is the general belief that the principal value of pulp will be found in aiding digestion and maintaining sound health of animals. It has also unquestionably a food value. I do not make any attempt, however, to estimate the value of pulp in units as compared with units of some other kind of food. I think no rule for the feeding of pulp is necessary. I do not think it is important whether a greater or less amount of it is fed in proportion to rough forage and grain fed with it. My idea would be, when on a full feed, to

give less than a full grain ration in order to be certain of securing some economy in the use of pulp. I should, therefore, feed cattle, for instance, anywhere from 40 to 60 pounds of pulp and let them have all the rough forage they wish.

FEEDS AND FEEDING.

In the foregoing discussion of feeding sugar-beet pulp it has been my aim to present the subject briefly and clearly to the farmers of the country. Wherever possible I have avoided scientific and abstract statements. I think, however, in concluding this subject a plain primary statement of some of the scientific and practical laws of feeding, including nutrition and assimilation, will not be out of place. In this discussion I make no claim to originality. I simply present the results of the scientific investigations and practical experiences of others.

PRINCIPLES OF NUTRITION.

Every farmer knows from practical experience that animal life is closely associated with vegetable life; from a business standpoint he should be more or less versed in the economy of each. His domestic animals are almost entirely vegetarians. Vegetable life is therefore our first important consideration.

In studying processes and formulating nutritive materials for vegetable growth, we have to deal with the original elements. Vegetable life is the great chemical laboratory in which are compounded the organic matter on which animal life depends. It deals with the elements, while animal life deals with the compounds of elements. If we examine vegetables and animals analytically we will find quite similar compounds in vegetable and animal structure, the only difference being that in the growth of vegetables these compounds are manufactured, while in the growth of animals they are simply taken as found in vegetable foods and assimilated. As a great writer on this subject has said, "The vegetable elaborates and the animal appropriates."

There are four kinds of substances which the feeder must furnish the animal to promote growth and repair, or secure valuable products: (1) water; (2) different kinds of organic compounds in which nitrogen is the basic element; (3) different kinds of organic compounds in which carbon is the basic element; (4) different kinds of mineral compounds.

Out of these various substances found in the vegetable are made up the muscle, fat, bone, integuments, hair, hoof, milk, etc., of animals.

Water is a constituent element that enters into all parts of animal and vegetable tissues.

In its daily ration the animal must secure sufficient of that kind of food represented by nitrogen, the basic element found in several compounds of vegetable life, such as albumen, casein, and fibrin. This is the food that builds up the organs and tissues, the bone, and the milk product. These nitrogen compounds are known to the chemist as

proteids, and, collectively, are called protein. The proteids contain about 16 per cent of nitrogen.

Aside from protein food, we must supply in the daily ration of an animal substances in which carbon is the basic element, combined with hydrogen and oxygen, and producing the fat, heat, etc. These are known as the carbonaceous parts of the animal's food, and include the fats and carbohydrates. The fats include the oil of indian corn and other seeds and grains, and the carbohydrates include such bodies as starch, cellulose, dextrin, cane and grape sugar, and gums.

We must also include in an animal's ration mineral material for the building up and repairing of the bones and to some extent the organs and other tissues by adding phosphates and carbonates of lime, phosphate of magnesia, potash, and common salt.

Briefly, the first step in building up and repairing the body is through the consumption of food by the animal, having in view mainly three things—the muscle, the fat, and the bones or framework. After the food has been digested, the work is carried on by circulation of the blood to various parts. A chemical analysis of the blood would naturally reveal the presence of all the parts represented in the body, viz, about 79 per cent water, 20 per cent organic matter, and 1 per cent mineral matter. In weight the blood averages about 6 or 8 per cent that of the body.

Referring to the plant as the original source of all material for animal growth, we find that it derives its substance from two sources, the soil and the atmosphere; most of the nitrogen, the mineral matter, and the water coming from the soil, and the carbon from the atmosphere. From the soil the plant derives water (hydrogen and oxygen), ammonia (nitrogen and hydrogen), and the various compounds of minerals forming the incombustible part of the body, made up of sulphur, phosphorus, chlorin, potassium, calcium, magnesium, silicon, iron, and a few others. From the atmosphere the plant receives carbon and oxygen, the basic principles of the carbonaceous or carbohydrate and fatty elements of the plant that enter into the animal food from which the fats of the animal are formed and from which are derived the other carbonaceous compounds of the food needed in its physiological enconomy.

Below is given a table published by Mr. Stewart,[a] based on analyses, giving the chemical composition of the whole body of an animal as represented in two of its states, lean and fat:

Average composition of animal bodies.

Condition.	Water.	Dry fat.	Nitrogenous or flesh.	Mineral substances.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Lean	54	25½	17	3½
Fat	49	33	15	3

[a] Stewart, Feeding Animals, p. 25, 1890.

From the above we see that chemically an animal represents four kinds of substance: (1) water; (2) fat or organic matter from carbon; (3) flesh or organic matter rich in nitrogen; (4) inorganic substances.

OBJECTS OF FEEDING.

Turning now from analyses to synthesis, we come to that part with which the farmer has to deal. He must make an intelligent study of the food ration. A proper ration is one that produces the results that he wishes to attain. Food rations may be classed according to the object in feeding, as follows:

(1) A ration for brood animals.

(2) A ration for the purpose of securing the most and the best milk. This is the concern of the dairyman.

(3) A ration that produces the best quality and greatest weight of carcass. This concerns the feeder for meat production.

(4) A ration for a working animal affording power and endurance. This is general, and applies especially to the feeding of draft animals, roadsters, and racing animals.

I desire to attract the attention of the farmers of this country to the great desirability of a careful study of feeding and the possibilities to be attained by the employment of proper food rations; and to place before them data carefully compiled by others, representing years of close, careful, and scientific investigation.

It must be borne in mind that my ultimate object in this discussion is to show the farmers of this country the benefits that may be secured by using sugar-beet pulp as a food for stock. This effort will be well repaid if it attracts the attention of a few farmers to the fact that here is a useful article of food, which, as the sugar industry develops, is bound to be enormous in quantity, but which is at present in many places absolutely going to waste. For some time to come this valuable food product can be secured far below its actual value measured by any scale of prices that yet obtains in this country. In many places factories would be glad to give it to the farmers to get it out of their way. This condition will exist until the farming communities appreciate its utility and create a competition among themselves establishing a commercial value which will gradually increase until such time as it shall be a staple commercial product.

In feeding stock a farmer may have in view several things, as follows:

1. In the life history of an animal there is a constant change of its tissues caused by continual breaking down and replacement with new material. This material is furnished by a daily supply of food. This fact must be kept in view whatever specific object the farmer may have in feeding the animal. Every move, every breath is at the expense of animal tissue. Destruction of tissue is the price the animal

pays for existence. These tissues must be constantly replaced. Some tissues are broken down faster and rebuilt more often than others. Akin to this process of restoring broken down tissues is that of building a young animal to mature size, having in view the even development of all its parts without emphasizing any one in particular.

It is the scientist's province to study the changes in animal tissues and to inform the farmer as to the correct proportions of the different compounds of food required in building up these tissues. This food must be furnished to the animal in the proportion with which these various tissues are torn down, or in accordance with the purposes of the farmer in building up the various parts. This is called a balanced food ration.

2. In case of feeding animals for the meat market, it is the purpose to fatten and build up a carcass of meat filling the requirements of commerce.

3. It may be the purpose of the farmer simply to keep an animal in good, healthful condition without attempting to produce meat or dairy products.

4. It may be the purpose to give the animal a strong, healthful constitution and muscular tissue for performing work, as is accomplished with draft animals and other beasts of burden.

5. It may be the purpose to feed for the milk product.

6. It may be the purpose to feed for the best results in breeding.

There are other things that a farmer might possibly have in mind, but these are sufficient for the present purpose. The feeder is yet untutored in his business if he do not have a clear idea of the kind of food that should be furnished an animal to accomplish whatever purpose he may have in view. As has been indicated in this article, if he is feeding for fat, then he should supply the animal food containing a large proportion of the carbonaceous elements; if he is feeding for muscle, then he should select foods having high percentages of protein; if he is feeding for milk, he should have both of these in view. With a definite knowledge of the constituent elements of plants, it is easy to control the results by selecting the proper plant food entering into the food ration. Some are excessively nitrogenous and some are excessively carbonaceous. Some plants are more evenly balanced in the proportion of elements required in the food of the animal.

To accomplish the first of the purposes of feeding enumerated above, that of obtaining a healthy condition or of rearing an animal from the young to maturity, it is evident that the ration should be one having a more narrow nutritive ratio than when fattening is the object; that is to say, there should be more of the protein and less of the carbohydrates and fats. Nature has furnished us a very valuable guide, especially in rearing and building up young animals. This is to be found in the constituent elements of milk, the natural food provided for rearing all

young. The farmer should examine into the composition of milk and compose his food ration somewhat after the pattern set by nature, especially after a young animal is taken off of milk. Below I give Mr. Stewart's table showing the composition of milk:

Composition of milk.

Constituents.	Cow's milk.	Mare's milk.	Ewe's milk.
	Per cent.	*Per cent.*	*Per cent.*
Casein, or flesh formers	4.05	3.40	4.50
Butter } food of respiration and fat	3.80	2.50	4.20
Milk sugar } food of respiration and fat	4.55	3.52	5.00
Salts or ash	.60	.53	.68
Water	87.00	90.05	85.62
	100.00	100.00	100.00

The second in the list of purposes mentioned is that of fattening. Nearly all ordinary grain foods are rich in fat and carbonaceous matter (see table, page 22). These are specially useful in the production of animal heat, but in their natural state they are not found to form part of the animal tissues. They may be classed as the fuel supplying the forces of animal life:

COMPOSITION AND NUTRITIVE RATIOS OF FEEDS.

It is not my intention to follow out the various purposes a farmer may have in view in feeding an animal. I have aimed to say enough to suggest the importance of every farmer giving careful attention to the food ration in order to accomplish the different purposes he may have in mind. We often hear the term nutritive ratio mentioned in connection with a particular ration or a single article of food. The nutritive ratio is simply the ratio between the nitrogenous and the carbonaceous elements found in the ration or the food. The ratio does not indicate the richness of the food in nutrient elements, simply the proportion of the elements of the two classes. The ratio expresses the value of the food measured by the purpose. If the farmer is fattening stock, he wants a wide nutritive ratio, and, therefore, leans strongly toward the carbonaceous. If he has in view a muscular development of the animal, he leans toward the nitrogenous in his food ration. In finding the nutritive ratio of any particular food we divide the amount of digestible carbonaceous matter in the plant, which is made up of the carbohydrates plus 2.25 times the fat, by the amount of the digestible nitrogenous matter. The farmer can supply the quantity when he once knows the quality. Different kinds of food vary greatly as to the amount of water contained. In the cereals the water content runs from 13 to 20 per cent; in root crops from 75 to 90 per cent. Two foods may be equally valuable so far as

the nutritive ratio is concerned, but very divergent in their commercial value on account of the difference in the amount of water and waste. In regard to milk Mr. Stewart says:

> If we take the analysis of cow's milk, as an example (milk being in solution, it is all digestible), fat is 3.80 per cent. This multiplied by 2.4 gives 9.12 per cent; and this added to the milk sugar, 4.55 per cent, makes 13.67 per cent as the carbohydrates of milk. If this be divided by the casein or albuminoids, 4.05 per cent, the result is 3.37, the nutritive ratio of milk (1:3.37) that is, milk has 1 part of albuminoids to 3.37 of carbohydrates.

It is not my purpose to go further into the discussion of the nutritive ratios or constituent elements of feeds in general. But I want to suggest to feeders careful examination of the data furnished in the following table of constituent elements indicating nutritive ratios of the common grains and other feeding stuffs entering into a food ration as furnished by Dr. E. W. Allen, Assistant Director of the Office of Experiment Stations in Farmers' Bulletin No. 22, on the Feeding of Farm Animals.

Dry matter and digestible nutrients in 100 pounds of feeding stuffs.

Feeding stuff.	Total dry matter.	Protein.	Carbohydrates.	Fat.	Fuel value.
Green fodder:	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Calories.*
Corn fodder[a] (average of all varieties)	20.7	1.10	12.08	0.37	26,076
Kafir-corn fodder	27.0	0.87	13.80	0.43	29,101
Rye fodder	23.4	2.05	14.11	0.44	31,914
Oat fodder	37.8	2.44	17.99	0.97	42,093
Redtop, in bloom	34.7	2.06	21.24	0.58	45,785
Orchard grass, in bloom	27.0	1.91	15.91	0.58	35,593
Meadow fescue, in bloom	30.1	1.49	16.78	0.42	35,755
Timothy,[b] at different stages	38.4	2.01	21.22	0.64	45,909
Kentucky blue grass	34.9	2.66	17.78	0.69	40,930
Hungarian grass	28.9	1.92	15.63	0.36	34,162
Red clover, at different stages	29.2	3.07	14.82	0.69	36,187
Crimson clover	19.3	2.16	9.31	0.44	23,191
Alfalfa, at different stages	28.2	3.89	11.20	0.41	29,798
Cowpea	16.4	1.68	8.08	0.25	19,209
Soy bean	28.5	2.79	11.82	0.63	29,833
Rape	14.3	2.16	8.65	0.32	21,457
Corn silage (recent analyses)	25.6	1.21	14.56	0.88	33,046
Corn fodder,[a] field cured	57.8	2.34	32.34	1.15	69,358
Corn stover, field cured	59.5	1.98	33.16	0.57	67,766
Kafir-corn stover, field cured	80.8	1.82	41.42	0.98	84,562
Hay from—					
Barley	89.4	5.11	35.94	1.55	82,894
Oats	84.0	4.07	33.35	1.67	76,649
Orchard grass	90.1	4.78	41.99	1.40	92,900
Redtop	91.1	4.82	46.83	0.95	100,078
Timothy[b] (all analyses)	86.8	2.89	43.72	1.43	92,729
Kentucky blue grass	78.8	4.76	37.46	1.99	86,927
Hungarian grass	92.3	4.50	51.62	1.34	110,131
Meadow fescue	80.0	4.20	43.34	1.73	95,725
Mixed grasses	87.1	4.22	43.26	1.33	93,925
Rowen (mixed)	83.4	7.19	41.20	1.43	96,040
Mixed grasses and clover	87.1	6.16	42.71	1.46	97,059
Red clover	84.7	7.38	38.15	1.81	92,324
Alsike clover	90.3	8.15	41.70	1.36	98,460
White clover	90.3	11.46	41.82	1.48	105,346
Crimson clover	91.4	10.49	38.13	1.29	95,877
Alfalfa	91.6	10.58	37.33	1.38	94,936
Cowpea	89.3	10.79	38.40	1.51	97,865
Soy bean	88.7	10.78	38.72	1.54	98,569
Wheat straw	90.4	0.37	36.30	0.40	69,894
Rye straw	92.9	0.63	40.58	0.38	78,254
Oat straw	90.8	1.20	38.64	0.76	77,310
Soy-bean straw	89.9	2.30	39.98	1.03	82,987

[a] Corn fodder is entire plant, usually sown thick.
[b] Herd's grass of New England and New York.

Dry matter and digestible nutrients in 100 pounds of feeding stuffs—Continued.

Feeding stuff.	Total dry matter.	Protein.	Carbohydrates.	Fat.	Fuel value.
Roots and tubers:	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Calories.*
Potatoes	21.1	1.36	16.43	.....	33,089
Beets	13.0	1.21	8.84	0.05	18,904
Mangel-wurzels	9.1	1.03	5.65	0.11	12,889
Turnips	9.5	0.81	6.46	0.11	13,986
Ruta-bagas	11.4	0.88	7.74	0.11	16,497
Carrots	11.4	0.81	7.83	0.22	16,999
Grains and other seeds:					
Corn (average of dent and flint)	89.1	7.14	66.12	4.97	157,237
Kafir corn	87.5	5.78	53.58	1.33	116,022
Barley	89.1	8.69	64.83	1.60	143,499
Oats	89.0	9.25	48.34	4.18	124,757
Rye	88.4	9.12	69.73	1.36	152,400
Wheat (all varieties)	89.5	10.23	69.21	1.68	154,848
Cotton seed (whole)	89.7	11.08	33.13	18.44	160,047
Mill products:					
Corn meal	85.0	6.26	65.26	3.50	147,797
Corn-and-cob meal	84.9	4.76	60.06	2.94	132,972
Oatmeal	92.1	11.53	52.06	5.93	143,302
Barley meal	88.1	7.36	62.88	1.96	138,918
Ground corn and oats, equal parts	88.1	7.01	61.20	3.87	143,202
Pea meal	89.5	16.77	51.78	0.65	130,246
Waste products:					
Gluten meal—					
Buffalo	91.8	21.56	43.02	11.87	170,210
Chicago	90.5	33.09	39.96	4.75	155,918
Hammond	91.9	24.90	45.72	10.16	174,228
King	92.8	30.10	35.10	15.67	187,399
Cream gluten (recent analyses)	90.4	30.45	45.36	2.47	151,420
Gluten feed (recent analyses)	91.9	19.95	54.22	5.35	160,533
Buffalo (recent analyses)	91.0	22.88	51.71	2.89	150,933
Rockford (Diamond)	91.3	20.38	54.71	3.82	155,788
Hominy chops	88.9	8.43	61.01	7.06	158,952
Malt sprouts	89.8	18.72	43.50	1.16	120,624

COMPOSITION OF SUGAR BEETS AND PULP.

The following figures, published in a recent issue of the Beet-Sugar Gazette (Chicago), will show the constituent elements of fresh, pressed, and dried pulp:

Composition of sugar-beet pulp.

	Fresh pulp.	Pressed pulp.	Dried pulp.
	Per cent.	*Per cent.*	*Per cent.*
Water	94.0	89.8	5.0
Ash	0.4	0.6	5.59
Crude protein	0.5	0.9	8.39
Crude fiber	1.4	2.4	22.35
Nonnitrogenous extractive matter	3.6	6.1	56.81
Crude fat	0.1	0.2	1.86
DIGESTIBLE MATTER.			
Albumen	0.3	0.6	.....
Nonnitrogenous extractive matter	3.0	5.1	.....
Crude fiber	1.2	2.0	.....
Fat	0.1	0.2	.....
Nutritive ratio	7.65	7.28	7.25

In order to compare the constituent elements and nutritive ratio of beet pulp with those of other common feeds, I will introduce the report of Dr. Wiley, Chief of the Bureau of Chemistry, Department of

Agriculture, on a sample of pulp that was sent by Mr. N. H. Stewart, one of the principals in the beet-sugar factory at Kalamazoo, Mich.:

JANUARY 21, 1903.

The SECRETARY OF AGRICULTURE.

SIR: In reply to your request for some information in regard to the relative feeding value of sugar beets and exhausted pulps, I beg to state that I have made the following investigation:

In addition to the analysis of the samples which were sent in the tin can from Mr. N. H. Stewart, of Kalamazoo, Mich., I made a comparative analysis of some beets which had been sent to the laboratory, and afterwards extracted the beets to the average extent to which they are treated in a diffusion battery, and thus secured a pulp from the same lot of beets at first analyzed. By making an examination in this way a direct comparison is secured between the beets and the pulps produced therefrom. The analytical data obtained are as follows:

Results of analyses of sugar beets and sugar-beet pulp.

Constituent.	In the beet.	In the pulp.	In the pulp from Michigan.
	Per cent.	*Per cent.*	*Per cent.*
Water	74.70	93.05	91.25
Ash	1.16	0.24	0.30
Fat	0.02	0.06	0.21
Crude fiber	1.38	1.30	1.59
Sucrose	15.80	0.35	0.00
Protein	0.43	0.66	0.84
Amids	0.85	0.03	0.05
Organic acids, soluble cellulose, and undetermined	5.66	4.31	5.76

The beets were prepared by removing all of the leaf stalks, but the necks were not cut away as is usually the case in the manufacture of sugar. In the study of the analysis of the beets and the pulps made therefrom this must be borne in mind. * * *

In order to compare the value directly, it is necessary to convert all of the data to dry substance. Converting the data to dry substance, we have the following table:

Composition of dry matter in sugar beets and sugar-beet pulp.

Constituent.	In the beet.	In the pulp.	In the pulp from Michigan.
	Per cent.	*Per cent.*	*Per cent.*
Ash	4.59	3.45	3.43
Fat	0.08	0.86	2.40
Crude fiber	5.45	18.71	18.17
Sucrose	62.45	5.04	0.00
Protein	1.70	9.50	9.60
Amids	3.36	0.43	0.57
Organic acids, soluble cellulose, and undetermined	22.37	62.01	65.83

In computing the nutritive value of the above, the quantities of soluble cellulose and crude fiber available must be determined by the ordinary results of digestion with these bodies.

It may be assumed from all of the data presented that 88 per cent of these bodies may be reckoned among the digestible carbohydrates. This would give the total digestible carbohydrate percentage for the beet, which is the sum of the sucrose and 88 per cent of the crude fiber, the organic acids, soluble cellulose, and undetermined, at 86.93 per cent. The fat multiplied by 2.25 added to this gives a total digestible carbohydrate and fat percentage of 87.11. The protein is 1.70 only, giving a ratio of 1 to 51.2.

In the pulp extracted from the beets the sugar, which consists of considerably more than half of the substance, was nearly all taken away. The relative proportions of fiber and cellulose are of course increased, the sum of the fiber and cellulose being 80.72 per cent. Assuming a digestibility of 88 per cent, we have a total percentage of these digestible carbohydrates of 71.03. Add to this the sucrose and 2.25 times the fat, viz, 1.94, and we have 78.01 as the percentage of total digestible carbohydrates and fat. Assuming, as in the case of the beets, that the protein is practically all digestible, we have the ratio of 1 to 8.21.

In the pulp from Michigan the sucrose had all fermented, except a mere trace, not sufficient to determine by chemical or optical methods. The sum of the percentage of crude fiber, soluble cellulose, etc., is 84 per cent. Assuming that it has a digestibility of 88 per cent, we have a total of digestible carbohydrates of 73.92 per cent. Add 2.25 times the percentage of fat, viz, 5.4 per cent, and we have a total of 79.32 per cent of digestible fat and carbohydrates. Assuming, again, that the protein is all digestible, we have a nutritive ratio of 1 to 8.26.

It will be noticed that in the above analysis the protein has been assumed to be all digestible. This is a fair assumption, because the indigestible nitrogenous bodies, viz, the amids, were separately determined and no account was taken of them in the nutritive ratio. As the amids are, as a rule, soluble in water, it is not strange that there is a very much larger percentage of them in the beets than in the pulp.

When figured on the dry substance, it is seen that the beets themselves form a food in which the nutritive ratio is excessively wide—that is, a food in which there is an immense excess of carbohydrates. On the other hand, the pulps produce a food in which the nutritive ratio is reasonably narrow. This difference arises from the fact that the carbohydrates in the beets are mostly soluble, while the protein is mostly insoluble, only the amid nitrogen bodies passing into solution. Thus, in the case of the extraction of the sugar in the diffusion battery, the percentage of carbohydrates in the dry substance is diminished, while the percentage of protein in the pulps is increased.

In regard to the quantities of water in the pulps, as determined by the ordinary method of drying, they are found to be 93.05 and 91.25, respectively. Since, however, some of the water in the pulp is doubtless in a state of hydration with the cellulose, a portion of it may still be found in the undetermined substance. For practical purposes, however, the data obtained in the analysis are entirely reliable.

I think the above data will give complete answers to your inquiries in regard to the beets and the pulps made therefrom for feeding purposes, and, in so far as I know, this is the only analysis on record in which the pulps represent directly the beets with which they are brought into comparison.

Very respectfully, H. W. Wiley, *Chief.*

Dr. Wiley's analysis of the pulp furnished by Mr. Stewart shows that the nutritive ratio is 8.26 and the nutritive ratio of the pulp produced from the beets in Dr. Wiley's work is 8.21. Stewart gives the nutritive ratio of Indian corn as 8.6, which is very nearly the same as that of pulp.[a]

The manager of the Alma Sugar Company, Mr. Hathaway, sent to the Department of Agriculture a specimen of dried pulp. The production of dried pulp in this country is a new industry. Up to date we have made very little progress in the production of dried pulp or in creating a demand for it after it has been prepared. Since dried pulp will very naturally play an important part in the beet-sugar

[a] Stewart, Feeding Animals, p. 140, 1890.

industry of this country in the future, the analysis of this sample is interesting at this time. The drying process at Alma gives evidence of success. In the process of drying, the waste molasses of the sugar factory is mixed with the pulp, and for this reason the nutritive ratio, 9.05, is a little wider than is that of plain pulp, either pressed or dried. Dr. Wiley shows that this pulp contains about 18 per cent sugar, while ordinary pulps show but a slight amount of sugar. This difference is due to the use of the waste molasses.

While this pulp product shows up strong as a whole, I am inclined to doubt the expediency or helpfulness of adding the molasses. It may promote fattening, and probably, as this waste molasses is of very little value to sugar factories up to date in this country, this may be the best means of disposing of it at present.

I give below Dr. Wiley's report on the dried pulp produced by the factory at Alma, Mich.:

JANUARY 28, 1903.

The SECRETARY OF AGRICULTURE.

SIR: The cattle food, composed of desiccated beet pulp mixed with molasses, and sent on by the Alma Sugar Company, of Alma, Mich., has been entered under No. 919 I. and W. The analytical data obtained on this sample are as follows:

	Per cent.
Moisture	4.01
Fat	.48
Crude fiber	14.25
Ash	4.97
Pentosans	20.94
Albuminoids	6.56
Amids	2.21
Sugars	17.99
Soluble cellulose, gums, starch, organic acids, and undetermined	28.59

The sample, when treated with water, was found to give 74.99 per cent of insoluble matter and 25.01 per cent of soluble matter. The soluble matter had the following composition:

	Per cent.
Cane sugar	14.16
Invert sugar	3.83
Salts and gums	3.01
Moisture	4.01

The above data show that this material is very dry, containing only 4 per cent of moisture, indicating that the process of desiccation has been very perfectly performed. When placed in hot water this material swells up very rapidly and assumes practically the bulk originally occupied by it when coming from the diffusion batteries. The analysis shows that about 25 per cent of the dry material comes from the molasses which has been used. It is seen from the data that the molasses has the composition of ordinary beet molasses which has been subjected to high temperatures, inverting a portion of the sugar. The indigestible portions of the material are represented by the crude fiber, pentosans, ash, and amids. I would say, however, in this respect, that a considerable portion of the crude fiber and the pentosans is digestible.

In regard to the amid nitrogen, it is well known that it is not anything like as valuable as protein or albuminoid nitrogen for food purposes. While it may have

some value in the system, it is not very great, and therefore I have reckoned it among the indigestible portions.

The soluble cellulose, the fat, the albuminoids, and the sugars are all digestible. Of course, only digestion experiments could determine accurately the proportionate digestibility of the sample, but it is safe to say, from the analytical data, that in round numbers two-thirds of this material is digestible and assimilable, and probably more.

As has been stated, it is not possible from a mere chemical analysis to indicate accurately the ratio between the digestible protein and the digestible carbohydrates and fat. A very good approximation, however, can be made of this ratio by a careful study of the analytical data. For this purpose the digestible carbohydrates in the foregoing sample may be taken as follows:

All of the soluble cellulose, gums, starch, etc., viz, 28.59 per cent; all of the sugar, viz, 17.99 per cent; one-third of the crude fiber and pentosans, viz, 11.73 per cent, and 2.25 times the fat, viz, 1.08 per cent, making a total of digestible carbohydrates and fat of 59.39 per cent.

While it is true that probably all of the albuminoids are not digestible, yet a sufficient amount of the amids would be digested to represent any deficit, so that the full number for albuminoids may be taken, viz, 6.56 per cent. The ratio then is $59.39 \div 6.56 = 9.05$.

It must not be inferred that the indigestible portions of the food are of no value. They serve to distend the digestive organs and to make possible the peristaltic action of the intestines necessary to the processes of digestion and assimilation.

Respectfully,

H. W. Wiley, *Chief.*

DETERMINATIONS OF NUTRITIVE RATIO AND VALUE OF PULP IN EUROPE.

In this connection I wish to introduce some extracts taken from the Yearbook of the Department of Agriculture for 1898, prepared by Guilford L. Spencer, assistant in the Division of Chemistry, on Utilization of Residuum from Beet-sugar Manufacturing in Cattle Feeding. The matter here used was prepared by him from observations made in the beet-sugar districts of Europe:

The following may be considered an average analysis of diffusion pulps:

Analysis of diffusion pulps.

Constituent.	Fresh pulp.	Dry material.
	Per cent.	*Per cent.*
Moisture	89.09	.....
Nitrogenous matter	0.92	8.43
Digestible carbohydrates	6.52	59.76
Indigestible carbohydrates	1.98	18.15
Fat	0.09	0.83
Mineral matter	1.40	12.83
Total	100.00	100.00
Solid matters	10.91	.....

The analyses, of which the above table gives mean results, were made by a commission of experts in France, including Messrs. Dupont, Vivien, Lucas, Duvin, and Durot. A brief résumé of feeding experiments conducted by this commission will be given further on.

A small percentage of cane sugar is included in the percentage of digestible carbohydrates given in the table. After the pulp has been stored in silos for a short time,

the sugar, which does not usually exceed from 4 to 6 pounds in quantity in a ton of the fresh material, gradually disappears through fermentation, and therefore is lost, at least in part, before the pulp is fed. The nutritive ratio (per cent fat multiplied by 2.25 plus per cent digestible carbohydrates, divided by per cent proteids) of diffusion pulps approximates 1:7.2. This is a medium ratio, and agrees fairly well with the Wolff-Lehmann standard for fattening a steer. A calculation on a somewhat different basis, assigning a money value to each of the constituents of the materials, indicates that beet pulp is worth about half as much as corn silage.

The usual European practice in feeding beet pulp to beef cattle is to mix a small quantity of linseed-oil cake and chopped alfalfa with the material.

The above table shows the nutritive ratio of pressed pulp to be 7.2.

In the development of the beet-sugar industry in Germany there have been several processes in general use for extracting the sugar from the beets. The pulp resulting from these different processes has differed in value for feeding purposes. It is probable that the feeding value of pulp is highest under the diffusion process now in vogue in Germany, and the world over for that matter. The change to diffusion processes brought on litigation in Germany, and, before the courts could settle the question accurately, it became necessary to carry on extensive and scientific feeding experiments to determine the value of diffusion pulp. In regard to the result of these experiments I quote again from Dr. Spencer's article:

The following animals were used in the tests: (1) Beef cattle; (2) oxen; (3) milch cows; (4) sheep; (5) ewes. Before beginning the tests the animals were all gradually accustomed to the change from their customary ration to diffusion pulp.

(1) *Beef cattle.*—Twelve beeves each received every day, in three meals, 115 pounds of diffusion pulp, mixed with 6.6 pounds chopped alfalfa and 6.6 pounds linseed-oil cake. Their weight increased an average of 2.214 pounds per day. Taking into account the values of the increased weight of meat, and of the alfalfa and linseed-oil cake, that of the diffusion pulp is $1.316 per 1,000 kilograms (2,200 pounds).

(2) *Oxen.*—Four oxen received each per day 126.8 pounds of diffusion pulp, mixed with 12 pounds of alfalfa and 2.2 pounds of linseed-oil cake. These cattle decreased in weight somewhat the first fifteen days and did less work than usual, but in the second fifteen days they had entirely recovered. The trial continued two months and a half. In making a calculation similar to the one above, the value of the diffusion pulp was $0.956 per 1,000 kilograms (2,200 pounds).

(3) *Milch cows.*—The test with cows lasted thirty days. Two cows were used, one Flemish, the other Dutch. Prior to the test the cattle were fed on dry alfalfa with a small quantity of press pulps from beets. The cows were each given per day 99.2 pounds of diffusion pulp with 4.4 pounds of alfalfa. The tests indicated that the pulp is of greater value as regards lactation than in the production of flesh. * * * The butter produced from this milk did not have the peculiar odor which is present in that from cows fed on press pulps.

(4) *Sheep.*—In this test 20 Merino sheep were fed on diffusion pulp. The rations fed per animal and the resulting increase were as follows:

	Pounds.
Average rations per head:	
Pulp	11.88
Linseed-oil cake	0.44
Chopped alfalfa	1.10
Weight of sheep:	
April 4	2,085.6
April 26	2,217.6
Total increase	132.0

The sheep eat the pulp with avidity; hence it is unnecessary to make other additions to it. On a basis of this experiment with sheep, the value of the diffusion pulp was calculated to be $1.74 per 1,000 kilograms (2,200 pounds).

(5) *Ewes.*—The ewes were obtained from a flock from which the lambs had just been separated. In feeding the ewes, to which a somewhat larger ration was given than in the preceding experiment, the value of the pulp was calculated to be $1.206 per 1,000 kilograms (2,200 pounds).

Not taking into account transportation, the commission estimated the value of the pulp per 1,000 kilograms (2,200 pounds) at $1.22, and from calculations based on a cattle food analysis, at $1.288.

From these experiments one may draw the same conclusion relative to the feeding value of pulp as was drawn from the analytical data, namely, the material is very fattening food. The experiments in question, and many others also, indicate that pulp may be fed to dairy cattle with great success. The results with cattle doing heavy work indicate that pulp will find its best application in fattening animals for the market and in feeding milch cows rather than as a ration for draft animals.

With a proper set of analytical tables showing the composition of different food plants, their content of digestible nutrients, and their nutritive ratios, the farmer who applies himself to the study of the subject and exercises good judgment can learn to feed his animals intelligently and profitably. Every farmer should have such tables and should apply himself diligently to working out suitable rations for his animals from such foods as are available. Correspondence with the scientists of his State experiment station on this subject will be time well spent, and will yield better returns than the same effort directed in any other way. Every intelligent farmer can make up his own feeding rations. It is too often the case that farmers are actually working in the dark on this subject. In many cases they have simply inherited the ideas and practices of their fathers, and have never given the subject of feeding any intelligent consideration.

In agriculture we are leaving the old, unsettled "hit-and-miss" methods, and along with the rest of the world are forced to apply the principles of economy and science.

Fortunate indeed is the farmer who is situated where he can secure sugar-beet pulp. For fattening we have been too much inclined to condensed rations, largely made up of cereals, hay, and water, too dry and too compact, requiring too much of the digestive organs. Sugar-beet pulp enters readily into any balanced food ration designed for specific purposes. No single item makes a food ration. This statement is as true of corn as it is of pulp, and vice versa. I would not undertake to discourage the use of cereals in the proper place in a food ration. I do wish to encourage the introduction of other foods along with them, especially succulent foods, a good type of which we find in sugar-beet pulp. It is available in large quantities, it is nutritious, and its sanitary effect is remarkable. Its aid to digestion is its strongest recommendation.

I wish now to call attention to the food rations for different purposes established in Germany after many years of scientific experiment and

RATIONS FOR CATTLE AND SHEEP CONTAINING SUGAR-BEET PULP.

actual experience. I would ask the farmer to examine these carefully, substituting whatever he may have for those things in the German ration which are not available.

From my last report I quote information furnished by United States Consul Baehr at Magdeburg, Germany, on the rations for cattle and sheep in which sugar-beet pulp enters. These are rations that the German people have worked out according to their experience as to how much sugar-beet pulp should be included along with other foods in a ration. Different kinds of rations are offered, made up of different kinds of feed, each including sugar-beet pulp.

Probably in no other country in the world has the feeding of beet pulp been studied and tested more extensively or scientifically than in Germany. This report is very interesting as giving the conclusions reached after years of experience.

In the headlines introducing each of the various food rations the consul gives the number of pounds of "dry matter" entering into the ration. This refers to the ration free from moisture. In the ration itself the weight given to each item refers to the food with its natural moisture. The consul gave in these rations the weights according to the metric system. I have given the equivalents in pounds avoirdupois.

In giving the "live weight" upon which each ration is based, the reader must not confound this unit of weight with the weight of a single animal. Several animals may be required to make up this unit of live weight. The rations as reported by the consul are as follows:

There is no difference between the results of feeding fresh pulp and that which has been stored in a silo. Both kinds have the same effect and are therefore used in equal quantities. The difference between them is that according to the manner of storing from 15 to 30 per cent of the substance is lost by decay in the silos. In the following tables moist pulp is referred to:

I. Draft oxen with fair amount of work.

Food requirements per 2,200 pounds live weight, per day—

	Pounds.
Dry substance, about	55.0
Containing—	
Protein	4.4
Fat	0.1
Carbohydrates	25.3
Ration recommended:	
Fresh pulp	132.0
Meadow hay	13.2
Summer straw	11.0
Winter straw	11.0
Malt sprouts	4.4
Cotton-seed cake	5.5

Ration for same with less work:

	Pounds.
Fresh pulp	88.0
Winter straw	17.6
Pulse chaff	26.4
Cotton-seed cake	3.3

II. Dairy cows.

Food requirements per 2,200 live weight, per day—

	Pounds.
Dry substance, about	59.4
Containing—	
Protein	4.4
Fat	8.8
Carbohydrates	24.2

Rations recommended to produce 16.5 pounds milk daily:

No. 1—	
Fresh pulp	66.0
Clover hay	11.0
Meadow hay	11.0
Oat straw	11.0
Wheat chaff	6.6
Malt sprouts	4.4
Oat bran	2.2
Palm-seed flour	4.4
Rice-seed flour	3.3
Meal	1.1
No. 2—	
Fresh pulp	88.0
Afalfa hay	11.0
Clover hay	6.6
Meadow hay	8.8
Winter straw	17.6
Rye bran	2.2
Coarse wheat bran	4.4
Cotton-seed cake	1.1
No. 3—	
Fresh pulp	110.0
Clover hay	13.2
Meadow hay	11.0
Summer straw	8.8
Linseed cake	4.4
Sesame flour	3.3
Winter straw	6.6

Rations recommended to produce 22 pounds of milk daily per 2,200 pounds live weight, per day—

	Pounds.
Dry matter, about	63.8
Containing—	
Protein	5.5
Fat	1.1
Carbohydrates	31.6
No. 1—	
Fresh pulp	77.0
Meadow hay	8.8
Clover hay	13.2

Rations recommended to produce 22 pounds of milk daily per 2,200 pounds live weight, per day—Continued.

	Pounds.
No. 1—Continued.	
Oat straw	8.8
Wheat chaff	6.6
Moist beer grains	44.0
Malt sprouts	4.4
Rape-seed cake	5.5
No. 2—	
Fresh pulp	99.0
Clover hay	19.8
Summer straw	13.2
Winter straw	6.6
Wheat chaff	4.4
Peanut cake	5.5
Palm-seed cake	11.0

III. Fattening cattle.

Food requirements per 2,200 pounds live weight per day—

	Pounds.
Dry matter	66.0
Containing—	
Protein	6.6
Fat	1.5
Carbohydrates	31.9
Rations recommended:	
Fresh pulp	110.0
Clover hay	13.2
Alfalfa hay	13.2
Barley straw	13.2
Moist beer grains	44.0
Bruised corn	6.6
Peanut cake	2.2

IV. Fattening sheep.

Food requirements per 2,200 pounds live weight, per day—

	Pounds.
Dry matter, about	61.6
Containing—	
Protein	7.7
Fat	1.3
Carbohydrates	31.9
Rations recommended:	
Fresh pulp	110.0
Alfalfa hay	26.4
Straw	17.6
Rye flour	12.1
Rape-seed cake	8.8

V. Growing cattle.

Six to 8 months old, weighing about 550 pounds, daily fodder, per head—

	Pounds.
Dry substance, about	13.86
Containing—	
Protein	1.39
Fat	4.40
Carbohydrates	7.48

Rations recommended:	Pounds.
Fresh pulp	22.0
Meadow hay	8.8
Summer straw	4.4
Oats	2.2
Sesame cake	1.1
Linseed	.29

Age about 12 to 18 months, weight about 748 pounds, daily rations, per head—

	Pounds.
Dry substance, about	18.04
Containing—	
Protein	1.54
Fat	.44
Carbohydrates	9.24
Rations recommended:	
Fresh pulp	22.0
Meadow hay	8.8
Summer straw	6.6
Oats	2.2
Malt sprouts	1.1
Palm-seed cake	1.1
Sesame cake	.5

VI. Growing sheep: Age, 8 to 11 months; weight, 101.2 pounds.

Food requirements per 100 sheep, per day—

	Pounds.
Dry substance, about	244.2
Containing—	
Protein	30.8
Fat	5.5
Carbohydrates	145.2
Rations recommended:	
Fresh pulp	200
Meadow hay	110
Pulse chaff	44
Oat chaff	22
Linseed	33
Rape-seed cake	33
Rye flour	22
Wheat flour	22

COMMERCIAL VALUE OF PULP.

The farmer is naturally of a practical turn of mind. When anything new is recommended he naturally asks what is its determined monetary value. All through this article on pulp feeding I have aimed to show that there are values to fresh pressed pulp that are undetermined. But I fully understand that the money value is the easiest understood. I will briefly summarize what I have shown with reference to the actual money value of pulp.

I. The Colorado experiment station concluded after exhaustive experiments that for certain purposes pulp costing $1.50 per ton could be fed at a profit.

II. The Michigan experiment station decided that a ton of pulp produced 41 pounds, live weight, of beef. This at 5 cents, ordinary price, gave the pulp, without profit, a feeding value of $2.05 per ton.

III. The New York experiment station decided that in feeding value a ton of pulp was equal to one-half a ton of silage.

IV. The courts of Germany in connection with litigation instituted extensive scientific and practical experiments in feeding, and arrived at the following conclusions:

(*a*) For beef cattle pulp is worth $1.32 per metric ton (2,200 pounds).

(*b*) For work oxen it is worth 97 cents per ton.

(*c*) For milch cows it is of much more value than for any other purpose.

(*d*) For sheep it is worth $1.74 per ton.

The commission determined that, not taking into account the transportation, the estimated value of pulp for 2,200 pounds to be $1.22, and it calculated the value by comparisons with other foods analyzed to be $1.29.

FOOD AS SOURCE OF FERTILITY TO SOIL.

As land becomes more valuable through density of population and its original fertility becomes exhausted, we are forced more and more to resort to fertilizers. In the older countries, like Germany, France, and England, where agricultural lands are worth $500 to $800 an acre, it becomes necessary for the farmers to produce the most possible at the smallest cost. This has led them to an exhaustive study of the application of fertilizers. We are moving in the same direction, and in the end we will have to give the subject as close attention as the people of any other country. The English feeder or farmer studies carefully the amount of fertilizer that will return to him again in the excretions of the animal when it is fed. He appreciates that there is no loss of matter, that it still exists somewhere in some state. When nitrogen, phosphorus, and potash are fed in an animal ration, he knows that whatever the animal assimilates makes up its muscles, brain, bones, etc. Whatever is not used by the animal is returned to him again in excretions, which he carefully husbands and restores to the soil. The only way he is deprived of any portion of fertility originally existing in the foods is by selling the carcass of the animal off the farm or by selling animal products, such as milk.

The following table, compiled by Dr. E. W. Allen, of the Office of Experiment Stations, shows the amount of nitrogen, phosphorus, and potash found in a number of ordinary plant foods entering into the ration of animals, the total value of these fertilizers per ton of feed.

Ash contituents and nitrogen of farm plants and products.

[Amounts and value per ton.]

Substance.	Water.	Nitrogen.	Potash.	Phosphoric acid.	Estimated fertilizing value per ton.[a]
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	
Hay of mixed grasses	239.8	28.2	31.0	5.4	$5.85
Timothy hay	150.4	25.2	18.0	10.6	4.98
Alfalfa hay	131.0	43.8	33.6	10.2	8.44
Red clover hay	226.6	41.4	44.0	7.6	6.53
Sugar beets	1,739.0	4.4	9.6	2.0	1.20
Mangel-wurzels	1,745.8	3.8	7.6	1.8	1.00
Turnips	1,789.8	3.6	7.8	2.0	.99
Carrots	1,795.8	3.0	10.2	1.8	1.02
Corn kernels	217.6	36.4	8.0	14.0	6.24
Barley[b]	286.0	34.2	9.6	15.8	5.49
Oats	363.4	41.2	12.4	16.4	7.25
Wheat (spring)	287.0	47.2	7.8	14.0	7.79
Wheat (winter)	295.0	47.2	12.2	17.8	8.17
Rye	298.0	35.2	10.8	16.4	6.30
Gluten meal	171.8	100.6	1.0	6.6	14.90
Cotton-seed meal	156.2	135.8	17.4	57.6	22.86
Linseed meal (new process)	155.4	115.6	27.8	36.6	19.62
Skim milk	1,805.0	11.2	3.8	4.0	1.97
Wheat bran	234.8	53.4	32.2	57.8	11.66
Wheat straw	251.2	11.8	10.2	2.4	2.32
Sugar-beet pulp and molasses cake[c]	1,400.0	5.8	7.6	2.2	1.31

[a] Fertilizing value per ton estimated by assuming nitrogen to be worth 14½ cents per pound, potash 5 cents, phosphoric acid 4 cents.
[b] Dietrich and König.
[c] Landwirtschaftlicher Kalender.

It would be impossible to give in general tables the amount of fertilizer returned in the manure, since it varies with the maturity, activity, and use of the animal. A young animal or a milk producer would return less than a mature or a work animal. The part returned may vary from 50 to 90 per cent. It may be roughly estimated that with the animals on the average farm 75 to 80 per cent of the elements of fertility in the food will be reclaimed again in the manure.

While I am not prepared to furnish the percentages of constituent fertilizers of pulp, I have given those of the ordinary feeds combined with it in stock rations. Since it stimulates feeding where available, these tables will suggest to the farmer the commercial value of his barnyard manures, and a careful saving and application of them will demonstrate the mutual relation between his feeding and cropping; also that sugar-beet pulp promotes both.

BRUSSELS CONFERENCE AND COUNTERVAILING DUTIES.

The most important event of the year affecting sugar production, an event which will be world-wide in its influence, was the action of the Brussels Conference. The results of the deliberations at this conference were the culmination of the natural desire of the several countries of Europe to relieve themselves from a serious economic muddle.

There are several countries in Europe in which sugar production is among the leading industries. In at least four of these countries, production of beet sugar largely exceeds home consumption. Each of these countries has been studying methods for encouraging production and exportation of sugar; each of them devised different plans, but all had the same end in view, viz, to pay a bounty on beet sugar exported to other countries. In order to derive a revenue to meet the bounties on exportation the Governments imposed large internal revenue taxes on sugar offered for home consumption. These taxes not only yielded sufficient funds to pay the export bounties, but contributed largely to the support of the respective Governments. Prior to the Brussels Conference, in France these internal excises were 60 francs per hundred kilograms (220½ pounds) on the greater part of the sugar produced. In Germany they were 20 marks per hundred kilograms (2.16 cents per pound). This was a tax on consumption of sugar; the people of France had to pay on sugar consumed 5.25 cents per pound, and the people of Germany had to pay on each pound of the sugar consumed 2.16 cents. This of necessity made the item of sugar in the daily living of these people quite expensive, ranging from 8 to 12 cents per pound, with the result that the consumption per capita annually in France is about 37.9 pounds, and in Germany 33.9, while in England and the United States, having no tax upon consumption, the per capita consumption of sugar is 88 pounds and 70 pounds, respectively. The present cost of sugar to consumers in the United States is about 5 cents per pound and in England about one-half a cent less. The bounty paid by Germany is direct, based on the amount of sugar exported in lots of more than 500 kilograms (1,102½ pounds), and is about 26 cents per hundred pounds of raw sugar. There are different bounties paid according to the grade exported, but this is the kind we import almost entirely. Our collector of customs requires in addition to the regular tariff[a] of $1.68½ per 100 pounds on German sugar, a countervailing duty of 26 cents, the equivalent of the bounty, making the tariff on the regular imported German raw sugar about $1.94½ per 100 pounds.

Prior to the Brussels Conference, France paid a direct bounty on raw

[a] The duty on raw sugar testing not above 96° polariscope is $1.68½ per 100 pounds. This is the standard grade on which prices are based.

sugar exported of 31 to 35 cents per 100 pounds on grades of sugar which we import, and so arranged the internal tax on consumption by crediting back tax on sugar exported as to pay a large indirect bounty. Our Treasury officials estimate this indirect bounty to be much larger than the direct. The excise requirement of 60 francs per 100 kilograms was based on a fixed return of 7¾ per cent of refined sugar. An additional yield above this paid an excise nearly one-half less. As a matter of fact the regular yield of refined sugar from the French beets is 10 to 11 per cent. Since all excises are rebated on sugars exported at the higher rate, viz. 60 francs per 100 kilograms (5¼ cents per pound) it is evident that on some of the sugar exported a larger rebate is given than the original tax paid. This difference is the "indirect bounty," and our Government has estimated it to be about 7.32 francs per 100 kilograms which, with the 3.50 francs "direct bounty," made 10.82 francs per 100 kilograms, equal to 95 cents per 100 pounds. This is the countervailing duty on French sugar required by our collector of customs in addition to the regular tariff of $1.68½ per 100 pounds, making a total duty of about $2.63½ per 100 pounds.

These countries all have heavy import duties in order to preserve their home markets for home-made sugars which carried heavy excises to meet public expenses and to pay these bounties on exported sugar. The German customs duty is 40 marks per 100 kilograms, or about $4.32 per 100 pounds. In France it is 60 francs per 100 kilograms of refined sugar, with a surtax on foreign sugars of 9 francs (in all about $6.04 per 100 pounds). The customs duty of Russia is 3 rubles per pood (about $4.28 per 100 pounds).

There are other beet-sugar countries than those mentioned which pay bounties on exported sugar. In effect their plans are quite similar, so that those given will suffice to illustrate the bounty system which has now been abolished by the agreements of the Brussels Conference, which was participated in by all European sugar-producing countries, except Russia. They subsequently exchanged ratifications, and bounties will cease September 1, 1903.

Russia's plan for encouraging export of sugar was more complicated. Each Russian sugar refiner is allowed to sell a certain quantity of sugar in the home market, called free sugar, upon which he pays an internal-revenue tax of 1.75 rubles per pood; this is equivalent to about $2.50 per hundredweight. On any excess of sugar produced by this refiner above the amount apportioned to him for sale he stands charged with an internal revenue twice as great as that on his allotted home sales, or 3.5 rubles per pood (about $5 per hundredweight). If he desires to export his excess he can do so under a permit from the excise office upon the return of a certificate with the custom-house export

mark; his excess holdings are then credited with the amount of sugar exported, relieving him of that amount of the duty of 3.5 rubles per pood. In this way he is encouraged to export. The Russian Government claims that it pays no bounty on exported sugar that is subject to the provisions of the Dingley Act, which requires all bounty-fed sugar coming to our ports to pay an additional duty over and above the regular tariff equal to the bounty paid by the Government where the sugar was produced. The general appraiser of customs has decided against the Russian claim; his decision was confirmed by the lower courts; it has recently been upheld by the Supreme Court of the United States; the Brussels Conference also held that these sugars were bounty-fed.

Russia refused to enter into the conference with other nations, claiming that its encouragement to sugar production is not a bounty on exports; that it is entirely a local affair with that nation and not subject to review by any conference of other nations. She still maintains this position.

The countervailing duty levied by the United States on imports of Russian sugar is 0.44 ruble per pood (about 63 cents per hundredweight) in addition to the regular tariff of $1.68½.

The Brussels Conference agreed that these bounties should cease September 1, 1903, provided the countries entering into the conference shall have indorsed its action, which they have since done. This does away with bounty encouragement in all the beet-sugar countries except Russia. The attitude of England occasioned this conference. She is a large consumer of sugar, but not a producer. Her markets were free for competition, with the exception of a recent war-measure duty requiring 1 cent per pound on imported sugar. Her consumption is about 1,500,000 tons annually. The effect of the export bounties paid in other countries was highly stimulating to production. The surplus sugars from these beet-sugar countries entered other markets highly subsidized, oftentimes selling at a price less than the actual cost of production. The market of England was the prize sought by all the sugar-producing countries. This placed the sugar-producing colonies of England at a disadvantage. The United States had put on an additional countervailing duty above their tariff sufficient to offset these bounties. England proposed to do the same, that her colonies might have a fair show in her markets. This situation would leave beet-sugar-producing countries with an abnormal production and bereft of the artificial means of disposal. The whole system tended greatly to overproduction. As a complication of this situation, local organizations in those sugar countries had combined in such a way as to control the production and markets of sugar. This can best be illustrated by the cartel of Germany. Since raw beet sugar

can not enter into direct consumption, the refiners organized what is known as the cartel, which allotted to each individual manufacturer his amount of production and sales and controlled the price. Whatever surplus over and above the home consumption was on hand was disposed of in England and other markets of Europe in competition with other European sugars and sugars from the Tropics. When these markets were supplied they could even sell, bolstered by the bounty, the balance in the United States at a profit, at less than the cost of production.

The effects of the Brussels Conference will be widespread throughout the sugar markets of the world. It will have a tendency to make the price of sugar more stable and undoubtedly to raise the same. It will cut down the world's production under the natural laws of supply and demand based on real factors of cost, with the artificial eliminated. This must necessarily benefit our home producers, whose product is not helped or stimulated by bounties. It will especially help our island possessions both in the East and West Indies. All the cane-sugar-producing islands of the Tropics have suffered immeasurably by the results of this world-wide cheapening of sugar by bounties. Unfortunately they had no large consuming class upon which to base a revenue supporting bounties on exports. Sugar production in these islands was very much depressed in consequence; in fact, it seemed in a fair way to obliteration. Porto Rico and the Philippines, along with the rest of these islands producing cane sugar, will be benefited by the restoration of a free, healthful competition, especially in the markets of England and other nonsugar-producing countries, or those partially supplying their demands, as is the case with the United States.

It is interesting to note the effect the Brussels Conference had on production in the sugar-producing countries during the past year. All of them realized that there was no longer a premium offered on overproduction. Without bounties, disaster was sure to follow if a retrenchment in output was not inaugurated. Russia, not signing the conference and contending that it had no bounty, was not similarly affected. I clip here an interesting item from the Modern Grocer, Chicago, Ill., January 1, 1903:

> The German yield of sugar is still the largest of all; but for the present season, down to December 13, it is only 1,703,800 tons, against 2,293,296 tons the year before. Austria-Hungary stood second a year ago, with 1,291,000, but is now third, with only 1,060,800. France was third a year ago, but is now a poor fourth, with a reduction from 1,109,673 to 818,600. Belgium, Holland, Sweden, and Denmark follow in order, each with a considerable reduction. The total product of these seven countries a year ago was 5,407,393 tons. This season it is only 3,990,698, a reduction of 1,416,695 tons, or more than 26 per cent. Russia, on the other hand, has materially increased her production from 1,076,250 to 1,184,240 tons, an increase of 107,990

tons, or more than 10 per cent, thus rising from the fourth place a year ago to the second place, and threatening in another year or two to surpass Germany and take first place as the largest sugar producer of the world.

Outside of the stability that the Brussels Conference lends to the future of the sugar industry generally, there are some very important deductions to be made touching its effects. Undoubtedly in those countries in which sugar has been so heavily taxed the per capita consumption will gradually increase with cheaper sugar. Without the necessity of collecting large sums for the payment of bounty, these countries are materially decreasing their revenue tax. France has reduced hers from 60 francs ($12) to 25 francs (about $5) per hundred kilograms (220.5 pounds). Germany has reduced hers from 20 marks to 14 marks per hundred kilograms. In the future the cost of sugar to the consumers in those countries should be materially reduced.

The conference is liable to produce some startling results touching other products. This high cost of sugar in France and Germany practically prohibited the manufacturing of some other things requiring sugar as a raw product. To-day England produces about 70 per cent of the jams and fruit preserves consumed in Europe by importing and working up fruits and sugar from France, and building up a trade in jams and preserved fruits in France and other countries as a result of this unnatural system of taxation. France is probably the leading nation of the world in the production of fruits entering into preserves and jams. Is it not likely that France will undertake to sustain the high production of sugar she has stimulated, not only by an increase in consumption, but by using it in building up a preserving industry? Furthermore, while France, under the new arrangement, requires 25 francs per 100 kilograms as internal revenue on the production of sugar, it only requires a revenue of 7.5 francs for the production of glucose. France has called a council of her sugar experts desiring information as to the wisest course to meet this serious situation brought about by the Brussels Conference. Out of this has grown the recommendation that France go into the jam and preserving industry, employing glucose as a raw material in the place of sugar. She may take the place of England in supplying preserved fruits and jams, and England in gaining "fair play" for her colonies in sugar markets may have lost her strategic position in making preserved fruits and jams.

From the above it appears that in requiring an article to enter into home consumption at a high cost to benefit exports, a government may deprive its people of some of the comforts and necessities of life, and starve some industries to build up others.

The following table (p. 76), showing the fiscal legislation of Germany, France, and Russia affecting raw sugar, was prepared in the Division of Foreign Markets, Department of Agriculture, and is appended to the foregoing discussion for reference.

Legislation of Germany, France, and Russia in regard to raw sugar.

GERMANY.

	Marks per 100 kilograms.	Dollars per 100 pounds.
Customs duty	40.00	4.32
Excise:		
Consumption tax[a]	20.00	2.16
Manufacturing tax[b] (not refunded on exportation)	.10	.01
Export bounty on raw sugar not less than 90° polariscopic test	2.50	.27
Cartel aims to keep the inland price of raw sugar at 25.50 marks per 100 kilograms, the increase above the world price not to exceed	6.80	.73
Countervailing duty imposed by the United States on raw sugar not less than 90° polariscopic test	2.40	.26

FRANCE.

	Francs per 100 kilograms of refined sugar.[c]	Dollars per 100 pounds of refined sugar.[c]
Customs duty:		
Regular[d]	60.00	5.25
Surtax (on foreign sugars)[e]	9.00	.79
Excise (not levied on sugar destined for export):		
Consumption tax, according to yield[f]—		
Sugar obtained up to the legal yield, 7.75 kilograms of refined sugar per 100 kilograms of beets	60.00	5.25
Sugar obtained above the yield of 7.75 kilograms and not above 10.50 kilograms	30.00	2.63
Sugar obtained above the yield of 10.50 kilograms	45.00	3.94
Manufacturing tax on raw sugar	1.00	.09
Export bounty (direct) on sugar testing less than 98° in the case of beet sugar or 97° in the case of colonial sugar and not less than 65°	1.11	.10
Countervailing duty imposed by the United States (on the same grade of sugar)	[g] 10.82	.95

RUSSIA.

	Rubles per pood.	Dollars per 100 pounds.
Customs duty	3.00	4.28
Excise:		
Consumption tax—		
Free sugar[h]	1.75	2.50
Other sugar	3.50	4.99
Refining tax	.005	.007
On exportation the excise tax is refunded and a certificate (having market value) is issued. This certificate permits an equal quantity of sugar to enter domestic consumption on payment of excise on free sugar.		
Countervailing duty imposed by the United States on sugar less than 99° and not less than 88°	.44	.63

[a] Sugar exported under Government supervision is exempted from this tax. Sugar produced by factories above their official allotment (contingent) is subject to an additional tax of 2.50 marks per 100 kilograms (27 cents per 100 pounds).

[b] In case of factories producing not more than 4,000,000 kilograms annually this tax is 0.10 mark per 100 kilograms (1 cent per 100 pounds). For each increase of 1,000,000 kilograms, or fraction thereof, in the annual production, the tax on the entire product is increased 0.025 mark per 100 kilograms (0.3 cent per 100 pounds).

[c] To estimate the yield in refined sugar, there are deducted from the absolute richness (as indicated by the polariscope) four times the quantity of ashes and twice the quantity of glucose. The yield is multiplied by the actual weight of raw sugar, less 1½ per cent allowed for loss in refining.

[d] Sugar imported from Martinique, Guadeloupe, and French Guiana is allowed a reduction of 2.25 francs, and that from other French colonies a reduction of 2.50 francs per 100 kilograms of refined sugar. Sugar imported from all French colonies is allowed a deduction for waste equal to the average surplus above the legal yield obtained by the domestic industry during the previous season; such waste is dutiable at 30 francs per 100 kilograms.

[e] Levied on actual weight. This surtax is not refunded in case of the reexportation of European sugar.

[f] Instead of these rates the manufacturer has the option of paying on 85 per cent of the actual production 60 marks per 100 kilograms ($5.25 per 100 pounds), and on 15 per cent, allowed as waste in manufacturing, 30 marks per 100 kilograms ($2.63 per 100 pounds).

[g] Apparently equal to 3.50 francs direct and 7.32 francs indirect bounty. The Treasury Department has not reduced its estimate since the French law was modified in August, 1902.

[h] Levied on the quantity of sugar allotted to each factory by the Government.

HISTORY OF THE BEET-SUGAR INDUSTRY IN THE UNITED STATES.

There are two distinct epochs in the history of the sugar industry in the United States—the first, 1830 to 1888; and the second, 1888 to the present. One is characterized by its failures, and the other by its rapid success. To those unacquainted with this history, the statement will be taken with surprise that we began the manufacture of sugar from beets seventy-three years ago, beginning when the world's production of beet sugar was in its infancy and the industry was battling for existence. At that time but little progress had been made in the methods, implements, and principles of agriculture. "The Great American Desert," bounded on the east by the Missouri River, rested as securely on the maps as did the great Rocky Mountain range west of it. In our agriculture science had no place worthy of the name. Our people generally thought the prairies of Iowa and Illinois and the farther West fit only for grazing. Farming lands must be sought in the timbered areas. These were cleared at tremendous labor and expense in order to secure cultivated crops. The idea of intensified farming resulting in the production of meat, butter, cheese, poultry, eggs, and vegetables was confined to the East, and was destined to work its way westward when conditions would permit.

Three facts contributed to the failure of our first efforts in producing beet sugar:

First. In the production of the beet crop and in the manufacture of sugar the methods were crude, and there was a lack of definite scientific information.

Second. Most early efforts in the production of beet sugar were, unfortunately, made in parts of our country having conditions which were not the best.

Third. Production of cane sugar, especially in the Tropics, had had a long trial, and the methods were thoroughly matured. Not nearly so much science, care, and cultivation is required with cane as with beets. Men with less intelligence can accomplish more through nature's help. Consequently, cane-sugar production was too strong a competitor for the new industry. The cost of beet-sugar production was so out of proportion to that from the tropical cane fields that these first factories in the United States could not survive.

The work of fighting the battles of the new industry was necessarily left to the older, better equipped countries of Europe, whose conditions were more settled and whose recourse to scientific help was more common. These countries, through a long, tedious struggle, gradually lessened the cost of beet-sugar production; bred sugar beets containing a higher percentage of sugar and purity, yielding a greater tonnage per acre; modified and improved their processes of extracting the

sugar from the beets, until about eighteen years ago the beet-sugar production of the world, for the first time, equaled the production from cane. From that time on the beet-sugar product rapidly increased over that from cane, until, in 1901, the total beet-sugar production of the world was 7,011,164 tons, while that of cane was only 4,042,575 tons. In this short period of time beet sugar had reached 63.4 per cent of the entire world's production.

Shortly after beet-sugar production had overtaken that from cane in the world contest the United States began to renew active interest in the former, and the result has been a most flattering success. No other industry has progressed with more rapid strides or enjoys to-day brighter prospects for the future. The factors that combined to bring about this magnificent result are four:

First. The time was ripe; our conditions were better understood; our efforts were more intelligently directed; we were better acquainted with the soils and locations adapted to this industry, and our tendencies were toward intensive agiculture.

Second. The cost of production of both beets and sugar had been so much lowered that the industry was no longer working under difficult competition with cane sugar.

Third. While Europe had demonstrated that, by high cultivation and intelligent effort, sugar beets could be made to compete profitably with cane, it was also evident that we possessed advantages even superior to those of Europe itself. Our land values are lower. The values of the German beet lands are $500 to $800 per acre. Ours can be made as productive with their natural fertility as those of Europe maintained at a high cost for commercial fertilizer.

Fourth. The most potent reason that can be given for the rapid ascendency of beet sugar over cane is the fact that the habitat of the sugar beet in the most highly civilized portions of the world brought to the manufacturer that concentration of the highest possible scientific investigation and achievement in the manufacture of the sugar product.

The early history of beet-sugar production in this country is a story filled with trials, struggles, and hardships. Enterprises were launched with hopeful expectancy and enthusiasm, only to find a final resting place in the junk piles. It is pathetic to study these abortive attempts, all of them illustrative of the courage, energy, and endurance of our pioneers in establishing infant industries, which have grown to be wonders of the world, objects of our national pride, the foundation of our wealth, and mainspring of our prosperity. These efforts were pursued with the tenacity and energy characteristic of the upbuilding of the Nation itself; without despondency or discouragement, these pioneers saw one failure follow another, leaving its legacy of experience, pointing out the shoals and dangers and making final success possible.

I find that very few are aware of the great losses incident to the first attempts in establishing beet-sugar industry. By corresponding with parties who have personal knowledge of the facts and from other available sources,[a] I have collected the following information concerning the early attempts to establish the beet-sugar industry in the United States.

PERIOD OF DISASTER, 1830 TO 1888.

1830.—In Philadelphia two gentlemen by the name of Vaughn and Rondalson erected the first American beet-sugar factory. The career of this enterprise was short. It produced during the year a few hundred pounds of sugar and then succumbed to the inevitable. The probabilities are that lack of knowledge concerning the growing of beets, lack of skilled help in the factory, and the poor quality of the sugar produced all contributed to the downfall of this enterprise.

1837.—One Dr. Hall, of Massachusetts, of an investigating turn of mind, had been traveling in France and became interested in the beet-sugar industry. He returned home, planted an acre of beets and produced sugar from them, probably by open evaporation. His product was exhibited at the meeting of the agricultural society, and he was awarded a prize of $100. This stimulated Mr. David Lee Childs, who had studied beet-sugar production in Europe, to erect a factory at Northampton. He had conceived a peculiar idea, which we hear promulgated even to-day, i. e., that of first drying the beets. In this manner they can be stored away and worked at pleasure, since the moisture is out of them and they are not so much subject to decay or deterioration. The crop of beets was about 13 to 15 tons per acre, yielding about 6 per cent of sugar, the estimated cost of producing the same being about 11 cents per pound. This factory, after producing about 1,300 pounds of sugar, was abandoned in 1840.

1852.—From the beginning of their history until recently the people of Utah lived within their own resources. In the pioneer days they endured many hardships, and, compelled by their location and environments, strove to build up the means of supplying their own wants. In 1852 Brigham Young, the head of the Mormon Church, conceived the idea of bringing a beet-sugar factory to Salt Lake City. In this attempt he was assisted principally by John Taylor, then a missionary to France, afterwards president of the Mormon Church. A company was organized in Liverpool known as the Deseret Manufacturing Company, with a capital of £50,000. A factory was purchased, placed on shipboard at this port and shipped from England to New Orleans, and thence by river to Fort Leavenworth, Kans., where

[a] I am indebted to Mr. Truman G. Palmer, of Chicago, Ill., for some of the data contained in this account.

it was unloaded. At Council Bluffs, Iowa, 52 wagons were specially constructed to haul the heavy machinery overland through the wilds and over the mountains to its far away destination. Long trains of wagons, pulled by several hundred oxen and manned by three score or more of men, started on this perilous trip. It pursued its way for days through hostile Indians, depending largely on the resources of the country for supplies, and was finally caught in a blizzard in the mountains, where many of the oxen and several of the men perished.

I am indebted to Mr. Horace G. Whiting, secretary and treasurer of the Utah Sugar Company, for the following account of this expedition:

The only record I have been able to find as to the cost of the machinery is a statement in the Life of John Taylor, by B. H. Roberts, which says that "Mr. Taylor had the machinery for the intended sugar works made in Liverpool by Faucett, Preston & Co. at a cost of $12,500. It was first-class machinery; the very best that could be obtained."

I have no way of telling what the cost of transportation was, but it must have been enormous, as the freight rate was then $800 a ton from the Missouri River to Utah.

The name of the vessel which brought the machinery from Liverpool to New Orleans was the *Rockaway*. It arrived in New Orleans the latter part of April, 1852. An account of the tremendous difficulties of transporting it over the Plains in wagons drawn by oxen is contained in the personal diary of Mr. Elias Morris, which I have had the pleasure of reading recently. The narration is identical with many of the stories of the pioneers of those days.

Mr. Morris says that Elder Taylor engaged a boat to carry the machinery from New Orleans to St. Louis. At that point he engaged another to transport it to Fort Leavenworth, where it was unloaded. He then went to Kanesville (Council Bluffs) to bring down the wagons which had been made to carry the machinery. This required considerable time, and, returning to Fort Leavenworth, they had another long wait for the company's cattle, but on July 4, 1852, they finally started for the West. The first day they made but 4 or 5 miles, but in that time several axletrees were broken, as the wagons had been badly made of green timber and were very heavily loaded. Some of the cattle, too, proved very wild. These delays constantly occurred; a great many cattle died on the way, and the result was that before three-quarters of the journey to the Salt Lake Valley had been accomplished, the company ran short of provisions. Their store was replenished by killing buffalo on the Platte River. Snow fell at the Sweetwater and the storm was so severe that the cattle were stampeded and before they could be found 10 had died. Eighty went astray. Then part of the train had to proceed, leaving the heavier wagons and a company of 6 young men behind to forage for their own food and recover the lost cattle. This they ultimately did, following after the main company. They missed the road, however, and went on toward Oregon until they struck the Green River, so that another long delay elapsed before the two companies were reunited.

The arrival in Salt Lake took place in the beginning of November, after a laborious journey of four months. Mr. Morris's journal adds that Elder Taylor had previously appointed Philip De Lamar, formerly of Jersey, England, to be captain of the company, and Mr. Morris himself was a captain of the first 10 and chaplain.

Mr. Morris's diary continues that the machinery was first taken to Provo, as that was the place agreed on for the location of the sugar factory. It took three weeks to travel a distance of 40 miles. By that time it had been decided to dissolve the

FIG. 1.—WAGONS LOADED WITH BEETS GOING ONTO DUMP FOR UNLOADING INTO CAR.

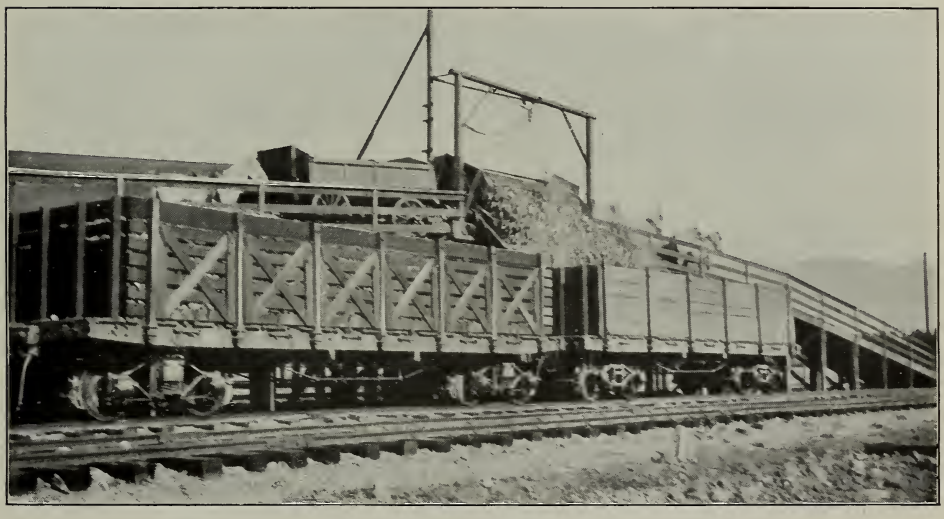


FIG. 2.—DUMPING THE BEETS INTO THE CAR.

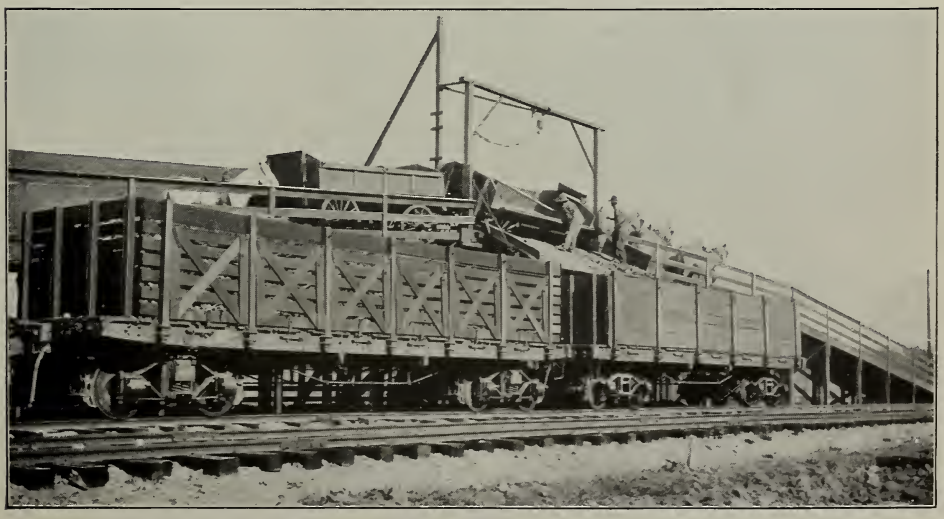
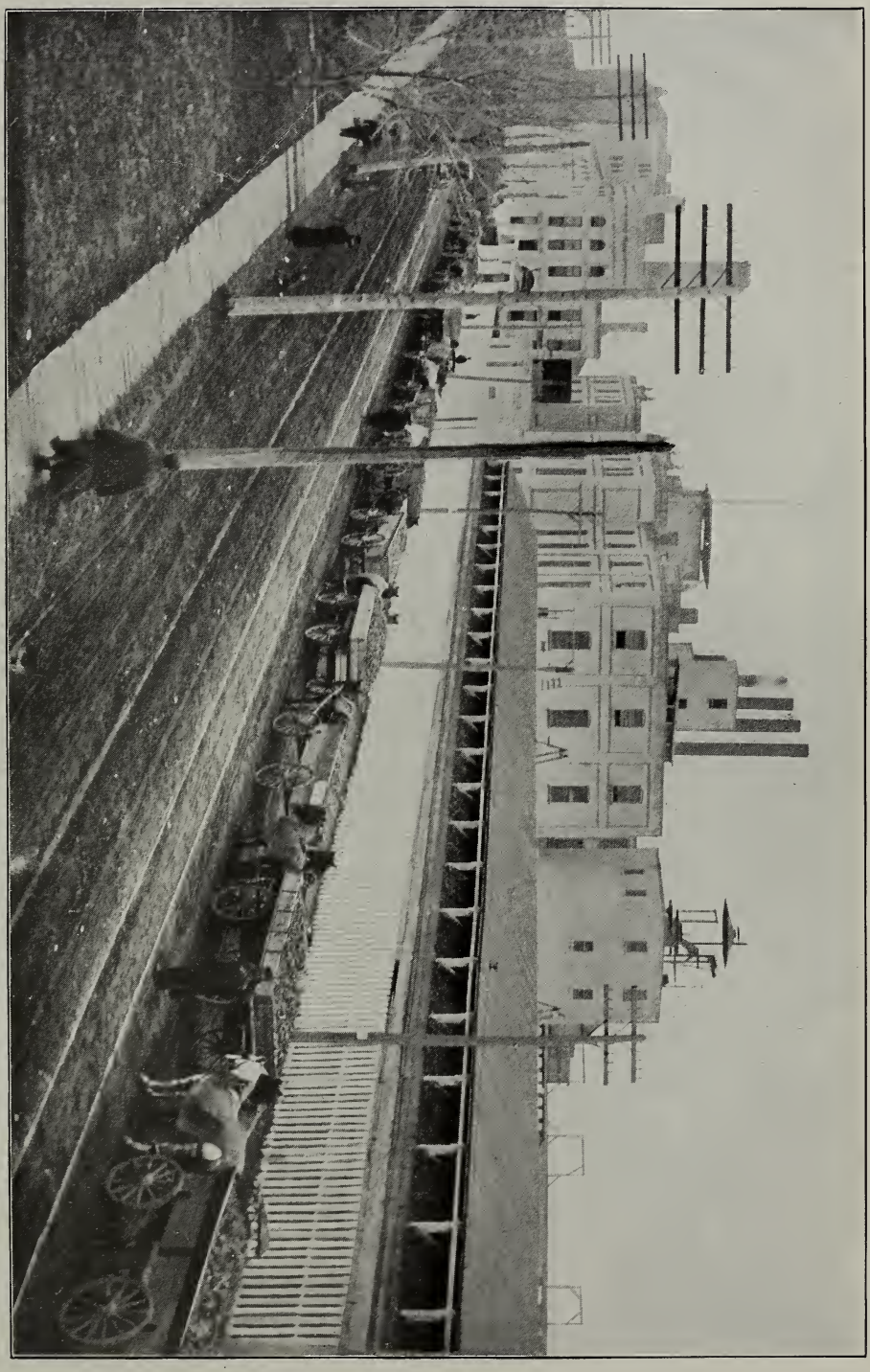


FIG. 3.—WAGON AFTER BEETS HAVE BEEN DUMPED INTO CAR, NEAR OXNARD, CAL.



FACTORY AT BAY CITY, MICH., WITH STRING OF WAGONS WAITING TO BE UNLOADED.

Deseret Manufacturing Company and the property was turned over to the Mormon Church. This seems to have ended Mr. Morris's connection with the first attempts to make sugar here until 1889, when the present Utah Sugar Company was organized; he was made the president and continued in that position until the time of his death.

Other authorities state that the mill was finally erected in what was called Sugar-House Ward, now a suburb of Salt Lake City, but for various reasons no beet sugar was ever made.

I am unable to tell what was the estimated capacity of the factory.

Roberts's Life of Taylor says that "the machinery was put in operation, but owing to a lack of skilled workmen to take charge of the various branches of the business the production of sugar was unsatisfactory, and at the instance of President Young the enterprise was abandoned."

W. C. A. Smoot, one of the original Mormon pioneers, now a resident of Sugar-House Ward, to whom I applied for information, says that a part of the sugar machinery arrived here in 1852, the remainder in 1853. No sugar was made; nothing but molasses. In 1854 the plant started up about the middle of November and ran until about the latter part of March, 1855, making only molasses. He adds that the beets had sprouted badly, which was the reason they could not be worked.

From other sources I learn that there was not at that time in this country any means of refining sugar or of extracting the potash salts which the molasses contained.

Some of the machinery of this factory is to be found yet lying around the junk and waste heaps, monuments of at least one failure made by this thrifty, industrious people.

1863.—I have been unable to learn of any other attempts to make beet sugar in the United States until 1863, when two Germans, one a capitalist, Jacob Bunn, and the other a manufacturer, Mr. Gennert, erected a factory at Chatsworth Park, Ill. This factory continued in operation until 1870, producing from 250 to 400 tons of sugar per year. The beets yielded about 8 per cent sugar. Lack of experience, bad management, and the inability of the factory to secure good water at Chatsworth Park contributed to its final failure. About $175,000 was expended in this effort. Mr. Bunn, who was a banker at Springfield and the principal stockholder, came into possession of the factory and moved the same to Freeport, Ill., where it was operated for a year by the Germania Beet Sugar Company; then it was moved to Blackhawk, Wis., to be operated as a cooperative concern. Here it suffered from lateness in completing the factory, poor crops, and failure of the water supply, and in consequence seems to have ceased operations in 1871.

1869.—In 1869 two Germans, Bonnesteel and Otto, erected a small factory at Fond du Lac, Wis., costing about $12,000. This enterprise was abandoned the next year, part of the machinery going to Blackhawk and part to Alvarado, Cal., where these parties joined with Mr. E. H. Dyer in constructing a factory.

Of this Fond du Lac enterprise it can be said that it was successful. Though cramped for means, its results were so favorable that it attracted the attention of capitalists of Philadelphia, who offered strong inducements to these parties to go there, but under the superior

offers of capitalists in California they moved to that State, abandoning what appears to have been a fair start in the right place, as all evidence to-day points to the favorableness of this locality.

1870.—An attempt was also made in New Jersey to manufacture sugar, ending in failure.

In this year Mr. Bonnesteel and Mr. Otto moved their plant from Fond du Lac, Wis., and joined with Mr. E. H. Dyer, organizing the Alvarado Sugar Company, constructing a large factory at Alvarado, the machinery for which, other than that shipped from Fond du Lac, was manufactured partly in San Francisco and partly in Germany. This factory operated until 1874, was closed down, and the machinery moved to Soquel, Cal., where it operated one year, under the management of Bonnesteel and Otto, the company failing in 1876.

During the year 1870 a factory was started by the Sacramento Valley Company at Sacramento, Cal., having a daily capacity of 300 tons of beets, at a cost for construction of $300,000. This factory operated until 1875. The machinery was sold to a company in Alvarado, Cal. This factory did not pay, for the reason, it is said, of the incompetency of the superintendent. It produced during the first and second seasons from 700 to 800 tons of sugar. During the last three seasons the plant was used in making molasses and rum.

1873.—A factory was erected at Ileton, Cal. It was of small capacity and inadequate for the production of sugar. The beets produced for it were poor and small. This factory operated several years, was closed down for a period, and attempted to make sugar again in 1880. It was finally closed up and most of its machinery sold for other purposes.

1878.—Up to this time no successful factory had been established. For several years preceding this date the annual production of beet sugar in the United States had fallen below 100 tons. Stimulated by a bounty of 1 cent per pound, in 1878 a refinery at Portland, Me., put in machinery for testing the feasibility of manufacturing sugar from beets. A beet-sugar company was organized for the purpose of exploiting this project. About $60,000 were expended, and trials covering a period of three years were made. The beet-sugar department of the refinery had a capacity of about 150 tons of beets daily. In 1881 this feature of the business was abandoned, largely for the reason that the farmers refused to grow the beets.

1879.—Mr. E. H. Dyer, of Alvarado, Cal., armed with the experience of his first failure at this place, and with the newer, larger, and better machinery of the factory shipped from Sacramento, started again in the manufacture of beet sugar, stimulating the organization of the Standard Sugar Refining Company. This factory had a capacity of 300 tons. The earlier effort had given the farmers some experience

in growing sugar beets. It had also given Mr. Dyer a great deal of information on the things to be avoided in the manufacture of sugar, as well as on the things to be done. His second attempt was under more favorable circumstances in every respect. Not only was the factory better equipped and more competent in every way, but it started with better help. This is the only one of all the factories started prior to this date which is still engaged in the production of sugar. It has the distinction of being the first successful pioneer factory. It is the spark in the smouldering ruins whose latent vitality caught the morning breeze of a new industrial activity, which fanned it into the flame of successful beet-sugar production in the United States. Its capacity has been enlarged from time to time, until it is now capable of working 1,100 tons of beets daily.

I reproduce here from a carefully prepared article by Mr. Truman G. Palmer a recapitulation of losses through failures prior to our period of success and including some more recent failures:

But a very indefinite estimate can be made of the financial losses incurred during the experimental stages of this industry.[a] The following table is given for what it is worth, nearly all of the larger losses being taken from authenticated figures of the companies operating the plants:

Losses through failures in the beet-sugar industry in the United States.

1830, Philadelphia, Pa	$100,000	1875, Soquel, Cal	$75,000
1838, Northampton, Mass	100,000	1878, Delaware	100,000
1863, Chatsworth Park, Ill	175,000	Portland, Me	100,000
1869, Fond du Lac, Wis	35,000	1892, Staunton, Va	100,000
1870, Freeport, Ill	75,000	1896, Eddy, N. Mex	200,000
New Jersey	100,000	Menominee Falls, Wis	200,000
Alvarado, Cal	250,000	1897, Rome, N. Y	200,000
Sacramento, Cal	75,000	1899, Pekin, Ill	50,000
1871, Black Hawk, Wis	75,000		
1873, Ileton, Cal	100,000	Total	2,110,000

The actual amount of money lost in the United States in experimenting with beet roots before the industry became established on a paying basis will never be known.

The loss in buildings and machinery represents but a small portion of the total amount of money which was swallowed up in experiments.

Five millions of dollars probably would not cover the direct and indirect financial losses of factory and field in the quest for European technical knowledge, to say nothing about the blasted hopes of communities and the bankruptcy of interested individuals.

The losses arising from nearly sixty years of universal failure have been more than compensated by the all but universal successes of the past ten years.

As in all other phases of life, the pioneers have paid the usual penalty of progressiveness, and to-day we are profiting by their failures.

1888 was the first year in our history when home productions of beet sugar exceeded 1,000 tons, and it terminated a series of disasters which had lined our pathway for over half a century.

[a] No attempt has been made to estimate the loss involved in Mormon failure of 1852.

The first requisite of a successful beet-sugar factory is a reasonable supply of good beets. It took eighteen years of struggling in Alvarado to overcome the apathy of the farmers, who at last began to realize that beet culture was a profitable line of agriculture.

The "factory expense" at this time had been reduced to $6.57 per ton of beets; the farmers were paid about $5 per ton, making a total cost to the factory of $12.57 per ton. The beets were high grade, the price of sugar 7 cents per pound, and the factory was able to make a profit of $1.50 per ton of beets worked.

Ten years later the Alvarado plant had reduced the "factory expense" from $6.57 to $2.71 per ton of beets, and the capacity of the factory had been increased from 200 to 800 tons of beets per day.

PERIOD OF SUCCESS, 1888 TO THE PRESENT.

Before going into the detailed history of factories representing the practical success of the beet-sugar industry I wish to refer first to some of the men who have been instrumental in bringing it about. I have already spoken of the elder Dyer, who practically belonged to both periods. He is often referred to as "the father of the industry."

Mr. Henry T. Oxnard, who had been identified with cane-sugar production, and had also made a study of beet-sugar production, in 1890 organized a company which built two factories in Nebraska. He has continued to work along this line until he is now at the head of a company which owns and operates five large factories and is maturing plans for others. (See Pl. III.)

Thomas R. Cutler, of Lehi, Utah, a pioneer in this work, early became impressed with the future of the beet-sugar industry, and interested the Mormon people in the possibilities of beet-sugar production.

He early discovered that at the time beets should be delivered at the factory there was a shortage in freight cars, necessitated by the demands for transportation of crops and of mining products. This induced him to install, at three different places, diffusion stations for extracting the juice. One of these stations is 20 miles distant from the main factory, and the nearest one is 10 miles. Pipe lines are buried in the ground, through which the juice is pumped from these diffusion stations to the main factory, doing away with the necessity of transporting the beets either by team or by rail. He has installed a permanent, practical, cheap method of delivering to the factory the juice of the beets. This innovation of pipe lines was met with the assurance of experts that it would be a failure. The pipe-line system had been tried in Europe and "found wanting," but it happened that it had never been tried by a "Yankee" before, and now the experts will have to reverse their verdict and say that it is a pronounced success.

Mr. Cutler found that fertilizer could be introduced into the Utah beet fields to a good advantage; at the same time he discovered that two islands in the Great Salt Lake, which had been occupied by two different species of birds (cranes and pelicans) as rookeries and places

for rearing their young, abounded in deposits of guano. It is quite generally believed that the Great Salt Lake contains no animal life, but there is a species of shrimp inhabiting this lake, tons of which are washed up on the shores of these islands, contributing also to this deposit of fertilizing matter.

Mr. Claus Spreckels of San Francisco, "father of sugar production in the Hawaiian Islands," several years ago transferred his field of active operations in sugar production from the Hawaiian Islands to the State of California, erecting a factory of large capacity at Watsonville, which he followed soon after with another of 3,000 tons capacity at Salinas. Mr. Spreckels has the distinction of possessing the largest beet-sugar factory in the world. The enormous demand of this factory can be indicated in no more graphic way than by stating that it is capable of working every day a train load of beets over 1 mile in length.

There are now in the United States many firms prepared to design and construct sugar factories of the latest and most improved pattern. We have manufacturers of machinery in our large cities thoroughly equipped to install the best and most modern machinery for manufacturing beet sugar. We have capitalists and promoters working for the establishment of new factories to develop our resources in beet-sugar production.

The following is the chronological order in which beet-sugar factories have been established since the "period of disaster" closed, together with a statement of the capacity of each:

1888.—The year 1888 marks the dividing line between failure and success in the production of beet sugar in the United States. In this year Mr. Claus Spreckels, of San Francisco, one of the original sugar producers of the Hawaiian Islands, and probably the most important, constructed a beet-sugar factory at Watsonville, Cal., with a daily working capacity of 300 tons of beets. This factory is notable as the first in the United States which has had continuous success from the beginning.

1890.—In 1890 Mr. Henry T. Oxnard erected his first factory, of 300 tons capacity, at Grand Island, Nebr. The operations of this factory and the farming conditions surrounding it, have probably contributed more than any other source to all the country east of the Rocky Mountains, in furnishing information as to the practical results of beet-sugar production.

1891.—During this year three factories were constructed at places and with capacities as follows: Norfolk, Nebr., 350 tons; Lehi, Utah, 350 tons; Chino, Cal., 350 tons.

1892,—The factory built by Mr. O. K. Lapham, of New York, at Staunton, Va., and operated for two years, accidentally burned to the

ground in 1895, and was never rebuilt. The beets grown for this factory were very good, yet it is not a locality considered favorable for this industry.

1896.—In 1896 a factory, the machinery of which was originally built and operated in France, removed to Canada, and then to Eddy, N. Mex. This factory had a daily capacity of 200 tons. It operated two seasons and closed down, since which time it has not been working. On February 3, 1903, for some unknown cause, it burned to the ground without insurance. This factory was one of the mistakes of beet-sugar manufacturing in the United States. In type of machinery and size it was unfit to compete with more modern concerns, and was a failure both in Canada and New Mexico.

The factory built at Menominee Falls, Wis., in 1896, was an absolute failure from the beginning; the crop of beets grown for it rotted in the silos. The causes contributing to this failure were due to faulty construction rather than to any natural causes or conditions incident to the locality, as is shown by the fact that a very successful factory is in operation there to-day. The new factory is made up of the old building, with entirely new equipment of modern machinery. It was found necessary to dispose of all the machinery of the old factory as absolutely worthless for this purpose.

1897.—A factory was constructed at Los Amitos, Cal., having a daily capacity of 350 tons. This was one of the first enterprises depending on the production of beets on new and unsubdued lands. The land surrounding this factory had been one of the oldest, largest, and best known sheep ranges in California. Sugar beets were successfully grown and the factory was able to declare a substantial dividend the first year.

In 1897 a small plant of French pattern was moved from Farnham, Quebec, to Rome, N. Y.; was operated a couple of years, and then ceased. This was also an old-style, second-hand factory of French design, and while in operation in New York maintained but slightly over 100 tons daily capacity. I understand that it is to be finally dismantled and the machinery disposed of.

1898.—A beet-sugar factory of 1,200 tons daily capacity was installed at Crockett, Cal., by the California and Hawaiian Refining Company. This company had been operating a plant at that place, refining Hawaiian sugars. It conceived the idea of installing a department for manufacturing and refining beet sugar during the natural campaign for working sugar beets, and devoting the rest of its time and energies to refining Hawaiian cane sugar. The association of these two industries is the unique feature of this concern; the beet sugar furnishing a raw product for the refiner, increasing the supply of the refinery to that extent. A great many plans have been proposed, involving the use

of the machinery of beet-sugar factories for a longer period than that afforded in the natural campaign for working beets. This combination of manufacturing and refining on the coast, using the raw sugars of the Hawaiian Islands and the raw sugar made from beets in the factory itself, or in others, is suggestive of what may be done by other western beet-sugar concerns.

The introduction of the beet-sugar industry now became very rapid. I shall simply record place, capacity, and the date of the establishment of later factories:

Factories built during five years, 1898–1902, with capacities.

	Tons.		Tons.
1898, St. Louis Park, Minn	350	1899, Fremont, Ohio	350
La Grande, Oreg	350	Lyons, N. Y	600
Ogden, Utah	350	Sugar City, Colo	500
Betteravia, Cal	500	Grand Junction, Colo	350
Bay City, Mich	500	Rockyford, Colo	1,000
Binghamton, N. Y	300	1900, Alma, Mich	600
1899, Pekin, Ill [a]	500	1901, Logan, Utah	400
Oxnard, Cal	2,000	Loveland, Colo	1,000
Salinas, Cal	3,000	Menominee Falls, Wis. [c]	500
Leavitt (Ames), Nebr	500	Saginaw, Mich	600
Waverly, Wash	350	Lansing, Mich	600
Bay City, Mich	750	Salzburg, Mich	400
Rochester, Mich	500	1902, Sebewaing, Mich	600
Caro, Mich	600	Carrollton, Mich	800
Kalamazoo, Mich	500	Mount Clements, Mich	600
Holland, Mich	350	Croswell, Mich	600
Benton Harbor, Mich. [b]	350	Eaton, Colo	600
Marine City, Mich	350	Greeley, Colo	800

Factories now building for campaign of 1903.

	Tons.		Tons.
Charlevoix, Mich	600	Fort Collins, Colo	600
Mount Pleasant, Mich	600	Windsor, Colo	600
Menominee, Mich	1,000	Longmont, Colo	600
East Tawas, Mich	600	Gardner, Utah	1,200
Owosso, Mich	1,000		

In presenting the above list of sugar factories, arranged according to the date of installation and giving the daily capacity at the beginning, I must call attention to the fact that a great many of these have since greatly increased their working capacity. I also call attention to the pertinent fact that recent factories are starting with much larger capacities. We are increasing the sugar output of this country not only through a large increase in the number of factories but

[a] Failed as a beet-sugar factory; afterwards run as a glucose factory.

[b] Failed, and in 1901 was dismantled and removed to Canada.

[c] The factory originally built here in 1896 was a failure; it was rebuilt in 1901 and is now in successful operation.

through building larger factories and enlarging the capacities of those already built.

It must not be assumed that all of the factories built during this period of successful operation have proven successful. Some of these, from one cause and another, have shared the fate of those built during the period of failure.

In 1899 a factory was constructed at Pekin, Ill., of 500 tons daily capacity. This factory operated one year. The surrounding country produced a crop of beets for the second campaign, but the company concluded not to continue longer in the production of beet sugar and converted the concern into a glucose factory, and the beets grown for 1900 were sold to the factory in Ohio and the one at Benton Harbor, Mich. There were probably two reasons contributing to this change:

First. The season during which the factory operated was not a favorable one for growing sugar beets. It was the trial year of the farmers on an entirely new crop. The beets were small as a rule and not high in their sugar content.

Second. This particular district is one devoted to extensive production of glucose and whisky. Parties interested in the beet-sugar factory were experienced in both of these other enterprises. The possibilities of producing glucose were well understood and those of sugar beets were indefinite. The first year's experience was not encouraging to sugar production.

In 1899 a sugar factory of 350 tons capacity was installed at Benton Harbor, Mich. It operated two years under unfavorable circumstances. It was late in building and completion, and the first year was not favorable to sugar-beet growing. The farmers were discouraged in their first attempts. The country surrounding this factory is devoted to vineyards and peach orchards, both of which are very profitable, producing fruit of a very fine and delicate flavor, which finds a ready and near market in Chicago and other cities adjacent. The farmers were so successful in producing peaches and grapes that they were loth to change to production of sugar beets; they were more inclined to plant all available lands in orchards and vineyards. The factory found it very difficult to procure a sufficient supply of beets, and in 1901 it was dismantled and removed to Canada, to engage in beet-sugar production there.

A factory was built at Grand Junction, Colo., in 1899, having a daily capacity of 350 tons. This factory has not been operating for the last two years, but must not be classed among the failures. It is a factory of modern make and equipment, and built throughout of brick, cement, and steel, and is located in the very fertile valley of the Grand River. This is probably one of the best fruit-producing districts in the Rocky Mountains, the whole enthusiasm and energy of

the people having been thrown into this enterprise. It is one thoroughly understood by the farmers and the results of which are very satisfactory. The sugar factory experienced from the start a difficulty in getting the farmers to give up fruit growing and devote lands to beet growing, which with them was new and untried. Practically the only land that could be secured was the new wild land. The farmers undertook here to bring this soil into cultivation by growing sugar beets for the first crop. It is well understood that sugar beets are not good as a pioneer crop, and while it may be said that the factory at Grand Junction failed to secure a sufficient supply of good beets, yet I am not at all prepared to say that the older and better cultivated lands of Grand River Valley will not produce a first-class crop of beets if given a fair chance. I expect to see this factory a thriving concern. Most of the soils around Grand Junction are gradually being brought under cultivation, and their condition is gradually becoming better for growing sugar beets or any other crop.

AN INSTRUCTIVE COMPARISON.

Comparing the status of the beet-sugar industry in 1903 with its status at the beginning of 1897, when the Department's work of fostering beet-sugar industry was renewed, and which marks the beginning of the great activity in factory building, I offer the following data:

In 1897 we had 8 factories, with capacities as follows:

	Tons.		Tons.
Grand Island, Nebr	300	Rome, N. Y	200
Norfolk, Nebr	300		
Alvarado, Cal	800	Total daily capacity, beets	3,750
Watsonville, Cal	800	Average daily capacity per factory,	
Chino, Cal	800	beets	469
Los Alamitos, Cal	350	Total daily capacity for production	
Eddy, N. Mex	200	of sugar	426

Working up to their full capacities for a campaign of 88.2 days (the average length of campaign in 1901), these factories would require annually 330,750 tons of beets, having a value of $1,323,000, and would produce 37,573 tons of sugar, having a retail value at 5 cents per pound of $3,757,300.

Counting three diffusion stations as factories, we had ready for operation in the campaign of 1902, 46 beet-sugar factories. Adding to this list 9 now building for the campaign of 1903, gives us a total of 55 factories, as compared with 8 at the beginning of 1897. The combined daily capacity of these factories is 37,200 tons of beets, as compared with 3,750. The combined capacity for a campaign of 88.2 days is 3,281,040 tons of beets, as compared with 330,750 in 1897. The number of factories has increased sevenfold, while the capacity has increased tenfold. The daily output of sugar of these factories is 3,720 tons, as

compared with 426 in 1897. The combined output of sugar for all the factories for the campaign is 328,104 tons, as compared with 37,573 in 1897. The value of this sugar at 5 cents a pound is $32,810,400, as compared with $3,757,300. The average daily capacity of these factories is 664 tons of beets, as compared with 469. The investment in these factories represents a valuation of $36,520,000, and a further investment of $18,260,000 of annual working capital to operate them, as compared with $4,248,000 and $2,124,000, the corresponding amounts for 1897.

This comparison of the status of the industry in 1897 and 1903 shows the progress brought about in six years.

Basing an estimate on the actual results obtained in our factories in 1901, our present factories would employ in common laborers to operate them 13,022 hands. To grow the beets for the factories would require 65,621 laborers on the farms. If we were to produce all the sugar we now consume in the United States, it would require the employment in our factories of 127,167 hands and on our farms for growing the beets 622,165 hands.

REVIEW OF THE BEET-SUGAR INDUSTRY BY STATES.

The following table shows the States in which beet sugar is produced, the number of factories which will be in operation in each State in 1903 with their agregate capacity, and an estimate of their annual sugar product:

Number of factories, with their capacity for working beets and producing sugar for 1903 by States.

State.	Number of factories.	Daily capacity in beets.	Annual capacity for production of sugar.
		Tons.	*Tons.*
Michigan	21	13,100	115,542
California	8	10,200	89,964
Colorado	9	6,250	55,125
Utah	[a]7	3,350	29,547
Nebraska	3	1,200	10,584
New York	2	1,200	10,584
Wisconsin	1	500	4,410
Minnesota	1	350	3,087
Ohio	1	350	3,087
Oregon	1	350	3,087
Washington	1	350	3,087
Total	55	37,200	328,104

[a] Three of these are slicing stations only.

MICHIGAN.

The State of Michigan manufactured her first beet sugar in 1898 at Bay City, and the following year 7 factories were located at Bay City (Pl. IV), Rochester, Caro, Kalamazoo, Holland, Benton Harbor, and Marine City; the next year, 1900, a factory was located at Alma; in 1901

factories were established at Saginaw, Lansing, and Salzburg; in 1902, at Sebewaing, Carrollton, Mount Clements, and Croswell; in 1903 factories will be put in operation at Charlevoix, Mount Pleasant, Owosso, Menominee, and East Tawas. To this State the sugar industry has come as a natural sequence of events in her industrial development. The business of the State had been founded largely on lumber production. This has overshadowed her farming interests, which were somewhat backward, considering the great agricultural resources of the State. When her forests were practically cleared, it became evident that the great lumber mills must shut down and other business interests must suffer in consequence. Naturally the people of the State turned their attention to their soil resources. When it became evident that conditions were favorable for sugar-beet production, all of the business interests naturally encouraged the establishment of factories. The State had the capital and organization of the lumber interests just retiring from lumber production. Under these circumstances a rapid development of the industry took place.

Sugar production has been confined to the lower peninsula until recently it invaded the upper peninsula, where there is a number of places whose conditions have been examined and where indications point to the establishment of sugar factories in the near future.

Five years ago all the sugar consumed in the State was produced outside her borders. At the present writing her factories are capable of producing annually 115,542 tons of sugar.

While it can not be said that the State has the best of soil for the production of sugar beets, yet the beets grown there are of a quality and purity acceptable to the sugar factories, and the net profits to the farmer compare very favorably with those from any of the other crops. Unfortunately the seasons have been erratic in the State of Michigan since the production of sugar began. Considered alone, the results of beet growing have been a little discouraging; but in comparison with other crops, the results appear very favorable. From a commercial standpoint, the geographical location of the State is very advantageous. The shipping facilities are probably better than those of any other State in the Union. Nearly surrounded by the waters of Lake Michigan and Huron, it has the advantages of easy and cheap water transportation. It is crossed by a network of railroads which reach the great shipping and commercial centers, such as Chicago, Detroit, and Buffalo. These are advantages that could not be permanently overlooked, so long as the State had an interest not fully developed. While engaged in lumber production, the natural energies of the State were absorbed in carrying out this enterprise. It called for considerable capital. The State's experience in lumber production was comparatively short, but profitable, and it monopolized attention. The State is just as favorably situated for

carrying out successfully any other manufacturing enterprise adapted to its natural conditions. Beet-sugar production, which fosters creameries and other enterprises, came as a favorable substitute for the waning lumber industry. The building of new beet-sugar factories at many points in the State is now proposed, and it appears quite probable that many of them will be constructed in the near future. It is evident that the State will soon not only produce enough sugar to supply its own wants, but will be sending a considerable amount to other markets.

CALIFORNIA.

This State has from the first led in the production of beet sugar. There are reasons why the people of California should have early engaged in the beet-sugar production, though not the same as those influencing the people of Michigan. Among the agricultural interests of the State the greatest development has been in the growing of small grain and fruits. Until quite recently irrigation had not been extensively employed, the farmers depending mostly on the natural supply of water. There are three classes of lands known to the farmers of the State—arid lands, damp lands, and lands under irrigation ditches. The fruit interests of southern California were confined largely to the last of these; on the damp lands were grown small grains. These lands were capable of retaining moisture sufficient to develop crops of small grain after a good supply of winter rain. They were called damp lands because of their peculiar capability of holding moisture, which probably came from the subirrigation or drainage of the water from higher levels. The dry lands were higher up and not nearly so valuable. It became evident to the farmers that they could not continually grow small grains; alfalfa was therefore introduced in rotation with other crops and was found very helpful in many ways, especially as a soil renovator, and sugar beets were tried with success.

Some years ago the State had a period of depression from which it has recovered. It was far removed from the Eastern markets, reaching them only by a long circuitous trip by the sea requiring several months, or overland by railroad requiring fifteen to twenty days or more. Many of the fruits grown in California are too perishable for long shipment. This necessitates preparation of the fruit by canning and preserving in different ways. California had a great many competitors in this prepared-fruit production, some of them much more favorably situated as regards the Eastern markets. Fruit production was not meeting expectations; it was overdone. Shipping the perishable fruits was more or less hazardous, and the canned fruits came into such severe competition with those more favorably situated that the growing of these fruits became somewhat discouraging. Sugar beets came to the State as a natural crop, serving to relieve the difficult

situation of both the grain raisers and the fruit growers. Since the introduction of sugar-beet growing, there has been a general improvement in agricultural methods and results, and a better understanding of the conditions of the State. Farmers have learned to plant earlier and take longer advantage of the winter rains. They have also discovered water resources which can be made available for irrigation through artesian wells, many of these flowing. While the beet-sugar industry has rapidly increased in importance, fruit growing has not lost its popularity as one of the leading industries of the State.

Many new beet-sugar projects are under contemplation in California, some of them having a capitalization of several million dollars, and including the building of irrigating ditches, along which are to be established at various places several factories, the ditch contributing water to lands for growing sugar beets for all of them.

California will probably always maintain a leading position among the States in the production of sugar beets as it does in other lines of industry. The building of an isthmian canal will probably give this State especial advantages that will greatly promote its progress.

COLORADO.

We are inclined to think of Colorado as a mining State, and in comparison with others she is fully entitled to be classed as such. It seems incredible to some people that the value of Colorado's agricultural interests is greater than that of her mining interests, and further that they are annually outstripping in growth her mining interests. Outside of grazing Colorado would not cut much figure in an agricultural way if the irrigating ditches were left out of consideration. It is through irrigation that the State is coming rapidly into prominence in the production of roots, cereals, and forage crops. Her soils are hardly excelled when sufficient water is placed on them.

The State experiment station in 1896 began extensive experiments in growing sugar beets in all parts of the State. These experiments, like those in many other parts of the United States, were conducted under very unfavorable circumstances. In order to test the different soils and sections of the State, the experiments were dependent upon farmers who had had no experience in growing sugar beets. Many of them were newcomers unacquainted with the proper methods of growing any kind of crop under Colorado's conditions. However, results of these experiments always indicated that conditions in the State were favorable to the production of sugar beets. A factory was built at Grand Junction in 1898. Another large factory was built in the same year at Rockyford. This place had attained considerable prominence in the commercial world by furnishing the famous "Rockyford" melons, of superior sweetness and flavor. It was assumed that a soil and climate which could accomplish such results with melons ought to

be very favorable for producing sugar beets. Experiments indicated this to be true. This factory was a great success from the beginning. Another one followed, 17 miles distant, at Sugar City, the same year; another at Loveland in 1901, and still another later. There are now 9 factories in the State. All of them have shown very high results in tonnage per acre. In sugar content of the beets, no other beet-producing area has ever excelled Colorado, year after year, the beets worked at some of the factories having an average sugar content of over 17 per cent. This average is far beyond the highest expectations of scientists when they began the breeding of sugar beets for a higher content of sugar.

There are a great many projects contemplated for utilizing other fertile valleys or parts of valleys in Colorado. Agriculture in this State was, prior to 1897, practically confined to grazing, alfalfa, potatoes, and small grains. It has extensive natural irrigation resources to draw on for further development. The great Rocky Mountain chain passes through this State. It is traversed by several streams, carrying the waters of the melting snows of winter and the rains of spring seeking outlet to the sea. Under the new irrigation laws this water will eventually be stored and held to supply the many fertile valleys of Colorado with sufficient water to produce abundant crops. The leading feature will be sugar-beet growing. The natural resources of soil and water supply will give to Colorado an advantageous position in the production of sugar beets. If any argument were needed to establish the feasibility of storing water, such as is contemplated by the new irrigation law, one needs only to mount the foothills or mountains north of Denver and cast his eye to the east over that broad expanse of fertile valleys. He will see hundreds of tiny lakes glimmering in the sunshine, awaiting only the opportunity when needed to enliven the activity of the soils throughout the valleys, producing those abundant crops for which the section is noted. These lakes are artificial, having been placed on these higher grounds by combinations of farmers or companies for the purpose of developing these beautiful valleys. They are crude attempts as compared with those contemplated by the Government under its new irrigation law. There is much waste in connection with them, but they have been resourceful in accomplishing the work of the designers. Reservoirs bounded by the rocky walls of the mountains will be much more permanent and efficient for storing these waters; a more comprehensive plan, under the direction of better engineers, will probably be a great deal more effective. But these hundreds of artificial lakes are conclusive evidence of the utility of storing water.

I must call attention to another thing favorable to manufacturing in Colorado. The mountain streams afford great opportunities for power. The same is true of Utah, Idaho, and other States of the

mountain region. This power can be transformed into electricity, which can be harnessed to the work of moving the wheels of machinery. This is actually taking place in Utah. The power producing electric lights of towns, used in operating street railways, in mining, and, to some extent, in the sugar factories is contributed by the rush of waters down the mountain sides. Such natural facilities aid much in cheapening the cost of production. They are the free contributions of nature which will continue for all time.

UTAH.

This was the third State to enter the field as a producer of beet sugar, the first factory being built at Lehi City in 1891. In this State again we find the introduction of this industry influenced by strong circumstantial causes. The farms in Utah are small, usually ranging from 10 to 40 acres. The farmers of Utah had gone further in the development and use of irrigation than in other parts of the United States. These small farms had been made as productive as possible, and afforded employment for a maximum amount of labor. Such conditions are ideal for sugar production. It is never advisable in starting the growing of sugar beets for a factory to encourage the farmers to put in more than 5 to 10 acres each; and, in fact, with most farmers who have acquired experience, it is never advisable to encourage a much larger planting than 10 to 20 acres. Some farmers are capable of handling a much larger field than this, but as a rule it is not advisable. There is no general field crop that requires so much outlay for labor as sugar beets, but there is probably no other crop that will meet the expense and return a good profit in addition so readily.

The people of Utah had been accustomed to supplying their own needs as nearly as possible by their own efforts; sugar was an item of importance in their daily wants. The production of sugar beets and the manufacture of sugar fitted so nicely into their system of farming and industrial life that it came as a matter of course as soon as the industry began to attract attention in the United States. That the wisdom of introducing it into Utah has been fully demonstrated is shown by the fact that this first factory has been able to produce it more cheaply than any other factory in the United States. The results of this first factory gave sugar manufacturing an impetus in Utah, and now they have, counting three rasping stations connected with the Lehi City plant, seven factories, with a combined daily capacity of 3,350 tons of beets and a practical estimate of annual output of sugar of 29,547 tons. The present annual consumption of Utah is 9,464.8 tons of sugar. Her production surpassed her consumption some time ago, and now the State is shipping over 20,000 tons of sugar to Missouri River points and other markets.

There are quite a number of projects under consideration in Utah,

having in view the utilization of large tracts of land in fertile valleys where additional water for irrigation purposes can be had. These lands are well located for utilizing water power, securing shipping facilities, and developing feeding and dairying. Utah is sure to continue, as it has started, one of the leading sugar-producing States of the Union.

NEBRASKA.

It will be noticed that in the case of the last three States, California, Colorado, and Utah, irrigation plays a leading part in the industry. The results in Michigan and Nebraska, where beets are grown under rain conditions, are offered in comparison. The mountain and coast States have some favorable conditions which Michigan has not, especially in the high sugar content of the beets grown there; but Michigan has some advantages in her location, markets and shipping facilities which the Western States have not.

Nebraska was the second State to enter the field of beet-sugar production, establishing a factory at Grand Island in 1890. This factory is about midway between the two extremes of rain conditions in Nebraska, the eastern portion securing sufficient rain for cropping, and the western portion being too arid for this purpose, but suitable for grazing. There are many things in the northeast quarter of the State that give to beet-sugar production ideal conditions, among which may be mentioned nearness of the stock range and facilities for feeding and shipping stock. The soil is generally a sandy loam, and seems adapted very well to production of sugar beets, corn, oats, and all kinds of forage.

There are three beet-sugar factories in the State, having an aggregate capacity for working 1,200 tons of beets daily and manufacturing 10,584 tons of sugar annually, the present annual consumption of sugar in the State being 36,467.5 tons. While there are other projects contemplated in Nebraska, some of which will probably materialize into beet-sugar producing concerns, yet I take it that sugar production in the State will not become an industry of predominating importance.

NEW YORK.

The situation in beet-sugar production in New York State is rather anomalous. Practical experience in manufacturing sugar has not entirely confirmed the results of experiments. In many places the soil and natural conditions for cropping are quite favorable to beet production. The transportation facilities can hardly be surpassed, even by those of Michigan. So far as its markets are concerned, it is probably more advantageously situated than any other State. The farmers are thoroughly accustomed to garden crops, dairying, and the uses of by-products of all kinds in their food rations. Yet it can not

PILE OF BEETS BY RAILROAD TRACK TOGETHER WITH FORCE EMPLOYED HANDLING BEETS, MINNESOTA SUGAR COMPANY, ST. LOUIS PARK, MINN.

be said that the results so far in New York in producing beet sugar are the most flattering. To me they have been quite disappointing. I had occasion to spend some time in New York during last fall about the time beets were harvested for the sugar factories and, in talking with the farmers in many sections where they are growing sugar beets, I found that the most reasonable explanation which could be given is the fact that sugar beets have to compete with too many other well-established crops in which the farmers are well posted and to which they are wedded to such an extent that they hesitate to give them up. There is a tendency among the farmers of New York to grow certain special field crops, differing from those grown on the cheaper lands farther west, with which they do not have to come into competition. I found one locality almost entirely devoted to peppermint, another one to broom corn, another to cabbage, etc. Farmers are receiving substantial returns from these crops and are satisfied to continue with them rather than take up others requiring more expense and labor in cultivation, such as sugar beets, even though remunerative in the end. Hence the factories in New York have not achieved great success, simply because, up to date, they have not been able to interest the farmers in growing sugar beets. There is no question but that the prospects are improving in this respect, and that the day is coming when sugar beets will receive a larger share of attention. Eastern farmers find some difficulty in selecting the field crops which will enable them to avoid Western competition. This competition has been felt so strongly and keenly that they hesitate to take up something new. There is no question but that it is a great deal harder in the State of New York to procure acreage for a beet-sugar factory than in any other part of the country. There are some projects being talked of for the future, and no doubt, while the State will be slower to take up the industry than some of the States farther west, in time it will show substantial interests in beet-sugar production.

WISCONSIN.

Attention has elsewhere been called to the fact that in 1869 a factory was established at Fond du Lac. It was of small capacity, but its equipment was up to date. The project was hampered for want of funds. I mention this factory here because, of all the contemporaneous attempts to manufacture beet sugar in the United States, this was the only one that gave evidence of success. It was not appreciated there at the time. The people managing this concern through superior inducements inspired by their work, were persuaded to go to California, not receiving sufficient encouragement to stay where they were. This was unfortunate. There is no telling what Wisconsin might be doing in beet-sugar production to-day had these people continued in their successful career at Fond du Lac. As it was they

went to California and failed. If they had stayed they would probably have succeeded and the industry in the United States would have received an earlier start and Wisconsin would have enjoyed its benefits.

Another attempt was made about five years ago at Menominee Falls. This failed for want of proper construction of machinery. The factory went into the hands of a receiver, lay idle for three years, and was finally bought up by a new company, reequipped with modern machinery, and is now a very successful enterprise. It is situated in a locality that has always shown good results in sugar-beet growing, both in the experiments of the State Experiment Station and in growing beets for both the old and the new factories.

Although Wisconsin has been unfortunate in the two failures mentioned at different periods, which have produced more or less discouragement, yet this State must be regarded as one that will eventually rank high in beet-sugar production. It has facilities for shipping and markets quite similar to those of Michigan; it is highly developed agriculturally; it ranks as one of the leading States in creamery production; it has a suitable soil, much of it higher and better drained than that of Michigan. It is available for inspection and exploiting by capitalists; it is experienced in manufacturing, and it has a farming element ambitious and progressive in agricultural development. There are no less than a half dozen projects contemplated that are likely to materialize as beet-sugar producing concerns no later than 1904.

MINNESOTA.

This State has one factory at St. Louis Park, near Minneapolis (Pl. V). This factory has worked the beets of four successive crops. At first it had difficulty in getting sufficient acreage to produce the required amount of beets. Farmers were accustomed to growing wheat, oats, corn, potatoes, and flax, and were not inclined to abandon these for a new crop. Sugar beets compared so favorably during the last two years, both under conditions of extreme drought and extreme wet, that the factory was enabled to overcome this obstacle, and had for 1902 about 32,000 tons of beets, giving it a fairly successful campaign. Farming is quite diversified in the southern portions of the State, and there are many localities well adapted to the cultivation of sugar beets and the production of sugar. The State is already experienced in manufacturing, being the leading flour-producing State of the Union. With its splendid facilities for growing sugar beets, natural conditions of soil and climate, shipping and marketing facilities, and a general tendency favorable to beet-sugar production, it must be reckoned as a State that will show considerable beet-sugar production in the future.

A few years ago the legislature of Minnesota enacted a bounty law to encourage the production of beet sugar in that State. In 1898 and 1899, under this law, bounties were paid to the Minnesota Sugar Com-

pany, whose factory is at St. Louis Park, near Minneapolis. In 1900 this company claimed as bounty $19,923.56 on its product of 1,992,356 pounds of sugar, but the payment was then refused on the ground that the act was unconstitutional. This led the sugar company to prepare a report of its operations, which it laid before the State legislature the past winter (1902–3).

As this report contains much information that is valuable to those interested in the beet-sugar industry, I introduce here a number of extracts from it:

The sugar content of Minnesota beets has been raised from 10½ per cent in 1898 to 15 per cent in 1902. The farmers have demonstrated for themselves that beet raising is more profitable than most other crops, receiving, as they did last year from the Minnesota Sugar Company, net returns, after deducting freight charges and cost of seed, ranging from $47.25 to $101 per acre for their crop, as shown by the figures given in this statement.

The Minnesota Sugar Company, during the year 1902, consumed about 64,000,000 pounds of sugar beets, which it received from 2,000 farmers, residing in 43 different counties of the State, paid therefor the sum of $157,241, and manufactured therefrom 8,706,372 pounds of pure white granulated sugar.

This company, during the five years it has operated its factory, has purchased from the farmers of Minnesota 222,644,024 pounds of sugar beets, paying for the same the sum of $522,694.50, and has manufactured therefrom 24,223,360 pounds of chemically pure white sugar. It has paid to the transportation companies in the way of freight $175,000, on which the State of Minnesota has received under the gross earnings tax the sum of $5,250.12. It has paid for supplies and materials consumed in the manufacturing process $250,000, and employs 300 men, to whom is paid in wages $700 per day.

This pioneer company has not only demonstrated the superiority of the soil and climate of Minnesota for growing sugar beets, but has opened up the way for a successful and profitable prosecution of the industry in all parts of the State.

SUGAR-BEET PRODUCTION AND FACTORY RESULTS.

The following table has been prepared to show the development which the agricultural side of the beet-sugar industry has attained in Minnesota. More than 2,000 farmers supplied beets for the factory in 1902; these are located in 43 counties, and the list of producing counties is increasing every year. In the table are given the principal shipping stations from which beets were received in 1902, the acreage at each of these shipping points, the quantity of beets shipped, and the amount received for them by the farmers:

Statistics of sugar-beet production in Minnesota for 1902.

Shipping station.	Number of acres in beets.	Number of carloads shipped.	Net amount of beets received at factory.	Amounts paid to farmers.	Local expenses for weighing and supervision.
			Pounds.		
Annandale	50½	17	801,174	$1,976.04	$102.05
Arlington	46	28	1,274,175	3,108.04	107.80
Augusta	10½	6	193,820	472.27	5.00
Belleplaine	26¾	12	462,505	1,159.10	54.42
Bixby	11	7	183,070	461.78	5.00
Bongards	34¾	20	831,425	2,031.48	99.02
Buffalo	23	11	421,445	1,027.60	25.00
Carver and Dahlgren	35½	18	769,783	1,878.35	50.70
Chanhassen	7¼	4	174,795	425.92	9.00
Chaska	22½	13	590,590	1,440.90	25.00
Cokato	135⅓	47	2,435,395	5,938.50	198.97

Statistics of sugar-beet production in Minnesota for 1902—Continued.

Shipping station.	Number of acres in beets.	Number of carloads shipped.	Net amount of beets received at factory.	Amounts paid to farmers.	Local expenses for weighing and supervision.
			Pounds.		
Cologne	9½	5	241,015	$587.11	$10.00
Dassel	244½	121	5,444,440	13,287.58	601.28
Delano	17	8	291,770	711.37	20.93
Dodge Center	28½	7	207,130	523.42	10.00
East Henderson	20	8	384,130	936.76	30.00
Eden Valley	47	12	563,869	1,374.39	47.48
Elk (Newmarket)	12	9	226,625	553.03	18.10
Empire and Vermilion	21	8	364,635	889.74	10.00
Faribault	19½	11	427,755	898.12	20.00
Forestlake	38	16	716,377	1,476.74	27.50
Gaylord	45	21	959,646	2,457.81	37.60
Glencoe	40½	24	942,645	2,298.95	78.00
Hamburg	25½	18	785,245	1,916.74	86.00
Hamel	12	7	276,930	674.75	11.00
Hastings	107½	57	1,956,980	4,498.24	119.95
Jordan	61½	29	1,282,275	3,127.60	74.10
Kilkenny	30	12	479,705	1,170.65	21.85
Kimball	52½	13	682,033	1,662.64	45.00
Lesueur	23	12	457,245	1,114.01	20.00
Lesueur Center	37	18	756,820	1,995.89	90.00
Litchfield	20	7	278,495	679.12	16.00
Mankato	40	19	691,380	1,700.00	11.00
Mapleplain	24	10	406,078	990.97	4.85
Mayer	18	10	405,330	989.33	20.00
Medford and Owatonna	53½	33	1,113,885	2,720.73	18.20
Mendota, Westcott, Nichols, Rosemount, and St. Paul	49	31	1,129,665	2,757.17	117.60
Montgomery	162	98	4,812,030	11,776.64	396.71
Morristown	13½	6	258,435	576.72	9.10
Morton	26½	10	397,829	1,008.44	23.00
Mulfords	27½	13	519,570	1,267.81	14.25
New Prague and Heidelberg	260½	115	5,159,875	12,618.16	605.91
Nelson	47	27	971,700	2,445.15	64.89
Nerstrand	10	5	153,035	373.86	12.00
Northfield	16	9	289,620	708.37	16.75
Olivia	21½	17	551,095	1,345.30	60.50
Otisco	21	5	256,725	628.45	4.50
Pennock	64	15	426,000	975.00	15.00
Plato	16½	10	377,635	921.51	30.00
Racine and Stewartville	29	11	380,020	959.57	15.00
Rich Valley	16	6	214,300	523.14	10.00
Robbinsdale	15	5	174,540	435.63	10.00
St. Bonifacius	9	5	182,745	446.25	10.00
St. Michaels	20½	8	253,650	618.30	10.00
Smithlake	18	8	354,125	862.93	5.00
South Haven	44	13	544,254	1,328.84	33.00
Vesely	8	4	107,270	271.52	.....
Victoria	7	4	138,160	336.79	5.00
Waconia	62½	33	1,466,350	3,698.05	119.58
Waterville	26½	14	428,335	1,048.19	21.70
Winthrop	22	11	463,939	1,164.19	31.50
Withrow	26	9	420,390	1,025.30	37.95
Young America	14½	7	404,550	986.71	14.05

In the following table are summarized the principal facts in connection with the operations of the factory for five years:

Statistics of factory operations for the five years 1898–1902.

Year.	Amount of beets received from farmers.	Number[a] of farmers receiving pay for beets.	Amount paid to farmers for beets.	Amount of chemically pure sugar made.	Wages[a] paid to agricultural employees.[b]
	Pounds.			*Pounds.*	
1898	[a]22,000,000	900	$46,413.54	1,994,700	$21,000
1899	42,871,080	1,500	99,414.59	4,581,463	23,000
1900[c]	39,126,124	1,400	92,646.69	2,715,000	25,000
1901	54,646,820	1,800	126,978.67	5,225,825	36,000
1902	[a]64,000,000	2,000	157,241.01	8,706,372	23,000

[a] In round numbers.

[b] This comprises the wages paid by the Minnesota Sugar Co. to field laborers and general farm help, and to instructors and overseers in the agricultural branch of the factory's operations.

[c] A bad year for all kinds of crops on account of continuous drought.

The Minnesota Sugar Company pays for beets $4.50 per ton, and pays 35 cents per ton on freight charges, making the cost of beets delivered at the factory $4.85.

It employs 300 men in its factory, day and night shifts, and its salary and pay roll amounts to about $700 per day. It furnished employment during the winter in the factory to a large number of farm hands, who cultivated the beet fields in the summer.

For supplies and material consumed in the manufacturing process the company paid, during 1901, $54,000, and during 1902, $66,000. It also paid in freight charges to the railroad companies of Minnesota during 1901, $35,000, and during 1902, $52,000.

Minnesota's soil and climate are admirably adapted to the production of sugar beets. Beets from this State took first prize at the Pan-American Exposition at Buffalo.

RESULTS SECURED BY SOME MINNESOTA FARMERS.

In the following table are compiled some figures showing the actual results secured by some of the most successful farmers growing sugar beets in Minnesota in 1901:

Some of the best results secured by sugar-beet growers in 1901.

Name and post-office of grower.	Number of acres planted in beets.	Growers' gross returns.	Growers' net returns.
Theodore Arens, Jordan	26	$1,842.15	$1,519.39
John Boo, Dassel	5	386.63	304.98
John Mathews, Plato	2	156.94	134.03
Wm. Huhs and Ed. Grimm, Waconia	*a* 40	2,439.29	2,065.19
Fred Buck, Hamburg	*a* 10	582.40	472.67
Fritz Bohnsack, New Prague	2	170.95	142.20
John Brezino, New Prague	2	203.11	167.65
John J. Dietz, Montgomery	2	144.28	117.95
M. M. Powell, Montgomery	9	546.85	442.03
Wm. Trapp, Mendota	2	147.36	124.62
Aug. Nachtigall, Westcott	3	160.58	131.14
John Lonien, Faribault	2	207.64	165.62
Louis Englund, Nelson	2	135.84	99.45
Wencel Hermann, Heidelberg	1	95.62	86.46
Johann Martin, Owatonna	1	80.26	70.14
Wm. Luehring, Hamburg	3	359.27	321.50
O. E. Stromberg, Buffalo	2	158.33	139.14
Geo. Dimler, Chanhassen	2	195.49	183.14

a About.

OPINIONS OF MINNESOTA FARMERS.

The opinions and acknowledgments of beet growers themselves are valuable as showing what the farmers think of this industry. The following are extracts of letters received from beet growers:

John Boo, Dassel, Minn.: I raised sugar beets on 6 acres, for which I received $50 an acre. That is better than to raise wheat.

Henry Arens, Jordan, Minn.: I planted 26 acres of sugar beets this spring. I have now received $1,519.39 from the factory for same. That is about $58 an acre. I am more than satisfied with beet raising. I shall raise 36 acres next year.

C. N. Cosgrove, Le Sueur, Minn.: I raised 35 acres of sugar beets last year. I am very well satisfied with the results. Every farmer who has suitable land should engage in beet raising.

William Huhs, Waconia, Minn.: I planted 50 acres of sugar beets this spring. The result is very satisfactory to me. I would advise all who have good land to plant sugar beets.

A. J. Broberg, Dassel, Minn.: I planted last year about 2½ acres of sugar beets. I have contracted for 10 acres for next year. I find that the cultivation of sugar beets is paying, particularly for a farmer who has a small place, because I can make just as much money from 10 acres planted to beets as a farmer can from 40 acres to wheat.

Aug. Johnson, Becker, Minn.: I received check the other day for beets raised on 15 acres of my farm at Becker. The distance from Becker to the factory is 50 miles. I netted about $40 to the acre. I am perfectly satisfied with the returns. I believe beet raising is a paying proposition, provided you attend to the beets. Farmers will say that there is a great deal of work connected with beet raising. Yes, there is a great deal of work connected with beet raising if you don't understand how to take care of them; but if you do the question of work will never bother you. I raised 15 acres last year and I shall raise 20 acres the coming year.

Mr. Fred Windmiller, Mankato, Minn.: In spite of unfavorable weather conditions and the comparatively high freight rate of $1 per ton last year, we cleared $25 net on each acre devoted to sugar beets on rented land with all help hired.

Charles Rihter, Montgomery, Minn.: Your checks at hand and all my farmers are well satisfied with your treatment. I can assure you 300 acres for 1903 at Montgomery. Some of my farmers are anxious to go into it to a large extent, from 6 to 20 acres each, but I would rather see smaller acreages and lots of tons of beets. With the results and treatment they are receiving they can be well satisfied. I am sure that every farmer who had beets planted in 1902 will contract again for one or two acres more than last year and lots of new farmers have asked for seed already. Send me a supply of contracts, instructions, etc.

Mathias Nohava, Wheatland, Minn.: The prospects for beet growing for 1903 will be very good. The farmers around this territory are very well pleased with raising beets. If we get a side track at Wheatland we will guarantee 500 acres of sugar beets.

Julius Radzam, Waconia, Minn.: Mr. Winkler, who planted 2 acres this year, received the money already for his beets and is very much pleased with it. He told me to put him down for 10 acres for next year. He has his land prepared. All the farmers who received their checks are well pleased and will double their acreage next year.

Jos. Hovorka, New Prague, Minn.: We have finished shipping from here and Suchomel Crossing, having loaded in all 113 full carloads, as against last year's 68, an increase over last year of 45 carloads. The people at Suchomel Crossing had a meeting last Sunday and then and there pledged themselves to plant at least 125 acres to beets next year. Here in the New Prague district there will be at least 300 acres planted for 1903. It is with great pleasure that I reassure you that all farmers are well satisfied. Certainly the sugar-beet industry has passed successfully its experimental stage and has come to be a great blessing to our small farms.

D. S. Todd, Hutchinson, Minn.: Your letter and check were received to-day. I am well pleased with the amount you sent. Am satisfied that there is money in raising sugar beets.

O. E. Stromberg, Buffalo, Minn.: I have shipped in all 74,860 pounds, or nearly 37½ tons, of beets. I consider this a good crop of beets from 2 acres, being nearly 19 tons per acre. My check for beets this year will be very much appreciated, as the sugar beet is the only product that will bring me any cash this year; all my other crops were destroyed by hail. Sugar beets are a sure and profitable crop to grow as hail and storms have no bad effect on them.

Frank Wickenhauser, jr., Cologne, Minn.: I will plant 2 acres next year, for I am very much pleased with last year's results. I could not have done as well with any other crop, for my single acre of beets yielded me more net than 9 acres of wheat, and I call that very good, and worth being recommended to others.

OHIO.

This State has a factory at Fremont. As in New York, it has been difficult to turn the farmers from their natural trend in producing special crops. There are in Ohio many places having conditions favorable to beet-sugar production. The farms are small and the soils are resourceful; the State has an abundance of fuel, splendid markets, cheap shipping, manufacturing experience, dense population, and stock-raising and dairying interests. There has been more or less talk about

establishing other factories, but none of them seem likely to materialize in the near future. I hardly think that the interest taken in the State has been commensurate with its natural advantages.

OREGON.

Oregon was one of the States originally conducting extensive experiments in growing sugar beets under the direction of Professor Shaw of the State experiment station. It was demonstrated at that time that there were many localities adapted to the successful introduction of this industry. A factory was established at La Grande in 1898, and, while this portion of the State had shown the best results under the experiments, the particular place selected for the factory was probably not the best, since the factory has been unable to interest the farmers in its vicinity to any considerable degree in production of sugar beets, but has been compelled to go to a valley at some distance from the factory to have its beets grown, and almost the entire supply of beets for the factory are brought in by cars. This factory is gradually overcoming its difficulties. I think there are many other places in the State where the sugar-beet industry might be introduced with advantage.

WASHINGTON.

This State was early exploited under the direction of the State experiment station in numerous experiments covering several years. A factory was established at Waverly, near Spokane. One of the difficulties in Washington has been the fact that the agricultural interests in the State are practically new. Agriculture consists largely in the production of small grains, for which the State has superior advantages. For this reason the factory at Waverly has found it difficult to secure sufficient acreage. However, Mr. Corbin, the owner, has been ceaseless in his energies and not lacking in faith in the outcome of the enterprise. Each year it is gradually working into better shape, and its future success appears to be established.

There is considerable interest in a proposition for establishing a factory southwest of Spokane, in what is known as the Yakima Valley. This is a large valley, very fertile, and especially resourceful in wheat growing. There are many reasons why it is favorable to the production of sugar beets. The next two or three years will probably see two or three more factories in the State of Washington.

REVIEW OF CONDITIONS AND PROSPECTS FOR NEW FACTORIES.

There is a prospect that many new beet-sugar factories will be installed during 1903. Most of these will be in States which already have one or more factories, but there is considerable possibility that the industry will invade some new fields.

ARIZONA.

It has been shown by extensive State and private experiments that there are several places in the State adapted to sugar-beet production. A company has organized and capitalized for building a beet-sugar factory of 1,000 tons daily capacity near Phoenix. This company appears determined to execute its plans. Last year it was arranged to build a factory which should be in operation for 1902, but it was deferred, and now it is intended to have the factory in operation for 1903. It is proposed to grow beets entirely by irrigation.

CALIFORNIA.

There are prospects for the construction of new factories at several points in California, among which the following may be mentioned:

ANTELOPE VALLEY.—The vice-president of the Antelope Valley Improvement Company reports that this company has already contracted for the construction of a factory and the building of the machinery. The factory, a 1,000-ton plant, will be built and in operation in the valley for 1903.

MARYSVILLE.—It is announced that arrangements have been made for building a sugar factory in Tehama County, between Tehama and Corning, and that a contract for the building of the same will soon be made. It is claimed that the power for the factory will be electricity, the same power being used in pumping water for irrigation. The factory is to be of 500 tons daily capacity.

MODESTO.—Another factory, of 600 tons daily capacity, is proposed for Modesto. It is a part of the plan of this company to locate a colony of Dunkards on the lands on which the beets are to be grown.

COLORADO.

The success of the factories already in operation has naturally resulted in the formation of many plans for the installation of new factories. The following are places at which there are good prospects for the construction of factories:

ALAMOSA.—For several years the farmers around Alamosa have been growing beets for sugar factories and testing local conditions. Several times agitation has almost culminated in the location of a factory at this place. Now it is announced that a company has been organized, capital has been subscribed, and a 600-ton factory will be constructed in this place in time for the campaign of 1903. The Southern Colorado Land Company has agreed to plant 4,000 acres of beets for the factory. A colony of Russians is being brought in from Kansas and other places to assist in growing the beets. It is the purpose of this company, it is claimed, to establish pipe lines similar to those at Lehi City, Utah, so

that juice can be pumped from slicing stations located in different parts of the county.

BRIGHTON.—Plans have been arranged to build at Brighton a 500-ton beet-sugar factory, and contracts are now being arranged with the farmers to grow sufficient beets to operate this factory for 1903. The promoters have secured up to date about two-thirds of the required acreage.

BRUSH.—It is announced by the Denver Times that the contract has been closed for the erection of a 1,200-ton factory at Brush, to be in operation for 1903, the chamber of commerce agreeing to furnish contracts for 5,000 acres of beets.

ARAPAHOE COUNTY.—It is the plan of the Denver Sugar and Land Irrigation Company to build a factory of 600 tons daily capacity in Arapahoe County, to be in operation for 1903. The company has purchased outright about 8,000 acres and controls in all 17,000 acres. The plan contemplates the rebuilding of the Castlewood Dam and the irrigation of the lands by this means.

FORT COLLINS.—A factory of 600 tons capacity is now building at Fort Collins, having five-year contracts covering 7,000 acres of beets. This factory is located at the home of the State agricultural college and experiment station, which did such effective pioneer work in paving the way for the establishment of the beet-sugar industry.

FORT LUPTON.—There is considerable talk of building a 600-ton beet-sugar factory at this place. Plans are immature, but the project must be classed among the possibilities.

FORT MORGAN.—I have advices from Colorado that contracts have been let for building a factory of 1,200 tons daily capacity at Fort Morgan. Contracts have been made with farmers to grow 5,000 acres of beets. The valley in the neighborhood of this place is irrigated by the Bijou Canal.

LAMAR.—There has been considerable talk for the last two or three years of establishing a beet-sugar factory at Lamar. Beets have been grown in this vicinity and always show good results. Recently an enthusiastic meeting was held here and 5,000 acres of land were pledged for growing sugar beets for five years under the guaranty of the Commercial Club. A committee was appointed and is now negotiating with capitalists to carry out this project. In view of the favorable conditions at this place, as shown by a long series of tests and the continued agitation in favor of the industry, this place will probably have a factory of 1,000 tons capacity ready for operation in 1903 or 1904.

LAS ANIMAS.—The farmers and business men of this vicinity have been agitating for some time the establishment of a beet-sugar factory. At a well-attended meeting recently 3,000 acres were pledged, and it

was evident that 8,000 acres could be readily secured if necessary. Negotiations are pending between those locally interested and outside capitalists for the purpose of erecting a 700-ton plant at this place.

La Jara.—At this point considerable talk has been had with refererence to establishing a beet-sugar factory. The farmers stand in readiness to grow the beets, business men are negotiating for the establishment of a 1,000-ton factory, and it looks as though such a factory may be constructed in the near future.

Longmont.—I announced in a previous report the interest taken by Longmont business men and farmers in establishing a beet-sugar factory at that place. It has been under consideration for some time by different combinations of capitalists. The efforts finally culminated in the closing of a contract recently for the building of a 600-ton sugar factory to be in operation in 1903. The factory building is to be large enough to double that capacity as soon as desirable, and it is probable that by 1904 it will be increased to a 1,200-ton plant.

Fowler.—At Fowler the farmers have made pledges to grow 5,000 acres of beets for a factory to be established at that place. It is announced by the officers of the Great Western Construction Company that a factory of 1,000 tons daily capacity would soon be established at this point. As securing acreage is the principal difficulty nowadays, and this company has overcome the chief obstacle, the probabilities are that a factory will be in operation here in the near future.

Holly.—The farmers around this place have been growing sugar beets for some time and disposing of them to the factory at Rockyford, but the Arkansas Valley Sugar Beet and Irrigation Company contemplates the establishment of a large beet-sugar factory at this place. Their lands have been disposed of in small lots of 40 acres, each of which has an abundant supply of water. It is quite probable that the factory will soon be built, either by this company or by other parties who have been considering the matter.

Manzanola.—For two years farmers have been growing sugar beets extensively in this section of the country for the factory at Rockyford. Results have been so encouraging that the farmers and business men of the section have organized and are negotiating with capitalists for the establishment of a beet-sugar factory. It is claimed that they have a proposition from a company to build a factory of 1,000 tons daily capacity at this place. A company was also organized in Denver, called the Manzanola Sugar Company, capitalized at $500,000, having in view the establishment of a factory here. Indications point to the building of a factory for 1903 or 1904.

Windsor.—A contract has been let for the building of a 600-ton factory, to be in operation for 1903. Contracts have been secured

with the farmers for sufficient acreage of beets covering a period of years, and the factory is now under construction.

OTHER POINTS.—There has been considerable agitation, with possibilities of success, looking toward the establishment of beet-sugar factories at Mosca, Montevista, and Platteville. There are quite a number of other places at which more or less consideration has been given to the establishment of factories. I have mentioned enough, however, to indicate that the whole State of Colorado is thoroughly alive to beet-sugar production and that it is bound to be one of the leading sugar-producing States.

IDAHO.

In order to encourage beet-sugar production in this State, the legislature recently offered a bounty of 1 cent per pound for the first year of the manufacture. There are several places in Idaho at which the establishment of beet-sugar factories is contemplated, having the conditions of soil, facilities for irrigation, water power, and other natural advantages.

BINGHAM.—Two companies have been testing the resources of the Blackfoot country. A company was organized especially for building a factory here, and, as the Utah Sugar Company had also entered this field, it was finally decided that the two should blend their interests in building a factory of 1,000 tons capacity. This has been decided upon, and a factory will be in operation in 1904, possibly in 1903.

RIGBY.—Some persons interested in the Great Western Sugar Company, of Loveland, Colo., have secured pledges from the farmers and propose building a factory near Rigby, or between that place and Idaho Falls. They propose erecting a factory of 500 tons daily capacity, to be ready for the campaign of 1904.

MOUNTAIN HOME.—The Idaho Beet Sugar Company is planning the erection of a large factory at this place in the near future. Beets are being grown experimentally, and indications are that the project is a strong probability.

UTAH.

BEAR RIVER.—The Utah Sugar Company is constructing in this valley a factory of 1,200 tons daily capacity for the campaign of 1903.

GUNNISON.—It is claimed that capital and acreage have been secured for building a 1,000-ton sugar factory at Gunnison for the campaign of 1903. This place has been quite thoroughly tested in growing sugar beets for several years for the factory at Lehi City.

WASHINGTON.

NORTH YAKIMA.—I have authentic assurance that a company organized at this place has secured capital and acreage and will build a 600-ton sugar factory for the campaign of 1903 or 1904.

EVERETT.—There are strong possibilities that a factory of 600 tons capacity will be constructed at this place in the near future. Capitalists have agreed to put up the plant provided acreage can be secured, of which there is little doubt.

NEW MEXICO.

Undaunted by the failure of the factory at Carlsbad and its final destruction by fire, people in the various sections of New Mexico are seriously considering the establishment of beet-sugar factories. Several valleys that have been pretty thoroughly tested by private enterprise have shown favorable results in beet production. At each of the following places a factory of 500 tons capacity is proposed: Albuquerque, Santa Fe, and Carlsbad.

MONTANA.

Through her State experiment station Montana is conducting investigations and experiments with sugar beets. The conditions and facilities are similar to those of Idaho and Utah. There are many fertile arid valleys in which sugar beets will succeed with irrigation. Several of these have been thoroughly canvassed. There are at least three projects in the State that will probably materialize in the near future.

NEBRASKA.

For some time a portion of the supply of beets for the sugar factory at Grand Island has been coming from the western part of the State, being grown by irrigation supplied by the Platte River.

MCCOOK.—Results in growing beets at this point have been so favorable that the farmers and business men in that section have been agitating the erection of a sugar factory and devoting some of their lands to the production of sugar beets. Considerable progress has been made toward establishing a factory. Local interests have the assurance from those interested in other beet-sugar factories that if sufficient acreage is pledged a factory will be built. It is probable that a factory of at least 500 tons' daily capacity will be in operation at this place no later than 1904.

OTHER PLACES.—There are several points in addition to McCook at which the establishment of factories is seriously contemplated. Among these are the following: Plattsmouth, Chadron, and Culbertson.

KANSAS.

The State experiment station carried on extensive experiments at the time other States were testing their conditions. These tests were confined mostly to the eastern portions of the State. Its reports were discouraging to the introduction of the beet-sugar industry. The

establishment in the eastern part of Colorado of factories at Rockyford and Sugar City revived the experiments and interest in the western part of the State. Sugar beets were grown and shipped to the factory at Rockyford. The results of these trials were so encouraging that there has been considerable talk about introducing beet-sugar manufacturing in western Kansas. Two years ago the legislature was induced to offer $1 a ton for all sugar beets grown in the State, and $10,000 was appropriated to pay the same. Each year has seen an increase in the production. There still remains about $4,000 of this bounty, and parties interested in sugar-beet growing are importuning the legislature to increase the amount. It is quite possible that two or three factories may be constructed. The following places appear prepared to furnish the acreage required and are striving to secure the interest of capitalists in building factories: Hutchinson, Wichita, Lakin, and Garden City.

IOWA.

This is one of the States in which elaborate experiments have been carried out by the experiment stations and by local organizations. Every part of the State has been quite thoroughly tested as to its conditions for growing sugar beets. In fact, in several localities sugar beets have been grown for factory use. Storm Lake, Fort Dodge, and Cedar Falls have grown several hundred acres for the factory at St. Louis Park, Minn. Nearly all of these points have been objects of careful consideration on the part of capitalists and farmers, with a view to establishing beet-sugar factories. There is no question about the existence of favorable conditions at these points, and capitalists who have looked into the matter are well assured of that fact. The difficulty has always grown out of the reluctance of the farmers to grow beets. I am more and more assured every year of the resourcefulness of the State of Iowa should it engage in beet-sugar production. It has the feeding and creamery interests, the railroads, the fuel; it has good market facilities for this product; it has generally an intelligent, industrious farming class; it has live, energetic organizations representing all features of agriculture, and it has considerable local capital. Iowa appears to take front rank in almost everything the people undertake in the way of crops or animal production. It probably could excel any other State in certainty of a crop year after year with a higher tonnage of sugar beets having sufficient sugar content and purity. The question naturally arises, "Why, with all their apparent advantages, have not the people of Iowa secured the establishment of the beet-sugar industry?" My view of the matter is this: The very prosperity of the State, with its diversified interests in agriculture, is the drawback. The farmers are prosperous, as a rule, in their present occupations, whatever may be their particular product.

They are not looking for some new industry, one which has the reputation of requiring so much expense and laborious work. I notice the sugar industry is going to the States where agriculture is new and where necessity requires the introduction of new crops in order to develop natural resources and take advantage of natural facilities. However, there is hope that some factories may be built. I confidently look for the establishment of several in the State within the next few years.

Council Bluffs.—An organization was recently effected with a capital of a million dollars having in view the building of a beet-sugar factory near Council Bluffs. A short distance north of this place, at Missouri Valley, from 1,100 to 2,000 acres of beets have been grown annually for the last three years for the factory at Leavitt, Nebr. These beets have been of good quality and tonnage per acre.

Sioux City.—Parties are interested in stimulating the building of a beet-sugar factory at Sioux City, with some indications of success.

WISCONSIN.

Chippewa Falls.—It is stated on good authority that the Wisconsin Sugar Company will construct a factory at this place, having a 600-ton daily capacity, to engage in the campaign of 1903.

Janesville.—From Janesville I am informed that the Wisconsin Sugar Company has proposed to the business men that it will construct at this place a factory of 500 tons daily capacity, provided sufficient acreage can be secured for the campaign of 1904.

Corliss.—It is claimed by the local business men of this place that they have sufficient assurance of acreage and capital for establishing a 500-ton sugar plant at that place for operation in 1903 or 1904.

Greenbay.—The Fox River Beet Sugar Company at this place has secured sufficient capital and nearly enough acreage for constructing a beet-sugar factory of 600 tons daily capacity to engage in the campaign of 1903.

It is claimed that the Wisconsin Beet Sugar Company also proposed to the business men of this vicinity that it would build a 500-ton plant if 4,000 acres pledged for growing sugar beets for three years could be secured. A sugar factory of this capacity will probably be in operation during the campaign of 1903.

Kaukauna.—It is authentically stated that a 500-ton sugar factory will be built at this place to be ready for the campaign of 1903.

Milwaukee.—For some time there has been considerable talk about constructing a large factory at Milwaukee having a daily capacity of 1,000 tons, capital to be furnished by wholesale and retail grocers. I am now authentically informed that this proposition has been matured and such a factory will be in operation at that place no later than 1904.

OTHER PLACES.—There are several other places in this State that have plans more or less matured that seem likely to culminate, eventually, in actual beet-sugar enterprises. These places are negotiating with capitalists, securing contracts for growing sugar beets, have local organizations, and are energetically pushing to the end of securing factories. The most important of these are as follows: Eau Claire, Racine, Sturgeon Bay, and Watertown.

ILLINOIS.

CHICAGO.—There has been considerable talk for some time by Chicago capitalists about erecting a large sugar refinery in Chicago and several beet-sugar factories at towns in the near vicinity. I believe this project contemplates that wholesalers and large grocers are to be the principal stockholders. Of course this scheme contemplates that those interested would also have the facilities for marketing the sugar. It looks quite probable that something of the kind will occur in Illinois not far in the future and that the State is liable to find itself the possessor of several sugar factories all under one combination.

There are quite a number of other places in Illinois where capitalists, business men, and farmers are agitating the erection of sugar factories, and it is probable that at some of these factories will be built sooner or later.

MICHIGAN.

Michigan, like Colorado, comes in with a long list of projects, most of which are likely to materialize. The interest in Michigan and Colorado is undoubtedly inspired by the large number of factories already in operation in these States. It is one of the best signs of the prosperity of the industry that so many new factories are contemplated in the localities where the industry is best known.

ALPENA.—It is announced that a factory has been secured for this place for the campaign of 1903 having a daily capacity of 600 tons. Most of the acreage has been pledged and capitalists have agreed to construct a factory. Indications point to its completion for 1903 or 1904.

BADAXE.—Capitalists have agreed to construct a sugar factory of 500 tons daily capacity at this place, provided water of sufficient quantity and purity can be produced. This has caused persons interested to sink deep wells, and it is claimed that they now have an abundant supply of pure water and the factory will be in operation for 1903 or 1904.

EAST TAWAS.—A local company at this place has secured sufficient acreage and has let the contract for building a sugar factory having a daily capacity of 600 tons to be completed for the campaign of 1903.

ENCORSE.—The Detroit River Sugar Company has let the contract

for a 600-ton sugar factory to be erected between the towns of River-rouge and Encorse. It is the purpose of this company to buy its own lands and grow its own beets and to be in operation for the campaign of 1903.

Gladstone.—Capital has been subscribed and most of the acreage secured for constructing a 500-ton sugar factory at this place to be in operation for the campaign of 1903.

Menominee.—The Menominee River Sugar Company is building a factory at this place of 1,000 tons capacity for operation in the campaign of 1903.

Traverse City.—The farmers around this place have agreed to raise 5,000 acres of sugar beets if a factory is established. Parties interested in other sugar factories have agreed to place the factory. Potatoes is the staple crop of this community, and the farmers are very well versed in growing root crops, and have had more or less experience in growing sugar beets for other factories. They are growing a large acreage of sugar beets for other factories for 1903, and it is quite likely that a sugar factory of 600 tons daily capacity will be established here for the campaign of 1904.

Mount Pleasant.—A factory is building at this place for operation in the campaign of 1903, with a daily capacity of 600 tons.

Owosso.—The Owosso Sugar Company is building a factory at this place for the campaign of 1903, with a daily capacity of 1,000 tons. This company has purchased 8,000 acres of land to assure a sufficient acreage of beets. It is not intended that the company shall grow all the beets needed, but that this amount of land will guarantee it a sufficient supply each season. This is a wise provision and suggestive to future factory builders in this State.

St. Louis.—A sugar company organized at this place has secured nearly enough acreage, and has entered into a contract with a construction company for building a 600-ton plant, to be in operation during the campaign of 1903.

Other places.—There are quite a number of other places in Michigan that have made more or less progress toward establishing sugar factories. Most of them have local organizations, a certain amount of acreage pledged, and more or less capital subscribed, and are in negotiation with capitalists and others with a view to maturing their plans. The following are some of the places at which factories are most probable: Sault Ste. Marie, Ypsilanti, Monroe, Portland, Mason, Manistique, Marquette, Houghton, Lapeer, Cheboygan, Marinette, Escanaba, Dundee, Battle Creek, and Cass City.

INDIANA.

From the beginning this State has been active through the work of the State Experiment Station and private parties in testing soil conditions with a view to establishing beet-sugar factories in different portions of the State. There are many places where indications point to the successful growing of sugar beets. The State has many natural advantages in the way of markets, transportation facilities, fuel, etc. A company organized and actually began constructing a factory at Shelby. Contracts had been made with the farmers, but the project was abandoned for some reason and the beets were sold to some other factory. Experiments in growing sugar beets and agitation in factory building has continued. At the present time the following places appear quite likely to have beet-sugar factories sooner or later: Butler, Fort Wayne, Vincennes, and Shelby.

OTHER STATES.

There is more or less well-developed interest in the State of New York looking to the establishment of other beet-sugar factories. The most probable locations are Le Roy, Newpaltz, and Troy.

At several places in Ohio, Pennsylvania, and Virginia the establishment of beet-sugar factories is receiving serious consideration. At each place experiments are being made and local organizations have been formed. The most prominent among these places are Dayton, Ohio; Philadelphia and Harrisburg, Pa.; and Newport News, Va.

STATISTICS OF THE SUGAR INDUSTRY.

The statistics of production of sugar beets, and manufacture of sugar therefrom, have been collected directly from the factories themselves. Statistics of consumption, imports, exports, etc., have been drawn from the most reliable sources.

STATISTICS OF THE BEET-SUGAR INDUSTRY IN THE UNITED STATES FOR 1902.

In the following table are compiled the results achieved by the beet-sugar factories and the beet growers of the United States in 1902. Most of the data came directly from the factories themselves. The acres planted, acres harvested, tons of beets worked, and amount of sugar produced were reported to me by the factories except in four cases. In three of these cases the reports are semiofficial from other sources. In one case only these items are estimated, the estimates being based on length of campaign last year, capacity of the factory, and comparison with results accomplished by other factories having like conditions during the past year. All the other figures appearing in this table have been taken from factory reports to me, with the

exception of some items which have been estimated from reliable data, and which are so indicated. More than half of the factories reported fully. The best reported only acreage, tonnage, and production of sugar. I regret that I could not include complete data from all these factories, as the results indicate so clearly the things to which we need to direct our attention in manufacturing sugar. The farm results brought out are interesting and instructive.

In order that the identity of the factories may not be revealed I have represented each factory by a number, the same number being used for the same factory in all the tables:

Factory and farm results for 1902.

Factory No.	Beet production.			Beets worked.			Average sugar—		Average purity coefficients—	
	Area planted.	Area harvested.	Average yield per acre.	Total amount.	Average cost per ton.	Total cost.	In beets.	In juice.	Of beets.	Of juice.
	Acres.	*Acres.*	*Tons.*	*Tons.*			*Per ct.*	*Per ct.*		
1				16,944			13.2		83.5	
2	3,000	1,800	9.0	15,032	$5.50	$83,050.00	13.8	11.7	84.8	84.8
3				26,000						
4	9,350	7,400	5.6	42,684	5.46	[a]233,054.64	13.6	14.6	85.1	83.4
5				22,000						
6	9,630	9,460	[a]6.8	64,063	5.25	336,654.00	13.3	9.9	83.9	84.9
7	4,800	3,600	7.5	28,000	5.25	147,000.00	13.5			
8	8,200	7,500	[a]6.0	45,000						
9	4,627	3,742	7.3	27,319	5.46	149,223.80	13.9	15.1	85.1	
10				30,000						
11				4,676						
12	5,500	5,000	7.5	38,499	5.39	201,323.98	14.7			
13	7,000	6,000	6.5	39,900	5.03	200,610.94	13.7		81.0	
14		3,500	[a]8.2	28,800						
15	7,124	6,651	[a]7.3	48,273						
16	5,300	4,000	[a]6.4	25,662						
17				14,000						
18	8,000	4,000	[a]5.6	22,532						
19				30,000						
20				30,800						
21	4,180	3,696	10.0	36,884	4.53	166,962.49	12.1	12 7	76.4	78.9
22				109,307						
23				41,000						
24	4,350	3,534	8.5	28,332	5.00	150,226.84	14.8	16.4	82.2	82.2
25				40,000						
26	10,200	9,300	12.5	113,670	[a]4.50	511,515.00	15.4		84.8	
27	4,250	4,200	10.0	42,472	4.65	[a]197,494.80	13.8	15.2	82.1	81.8
28	5,500	4,672	8.0	35,856	4.50	168,232.93	14.8		84.4	84.6
29	8,597	8,147	10.2	89,110	4.93	439,411.90	14.8	15.9	83.6	83.6
30	5,200	5,113	[a]9.6	48,970						
31[b]										
32	6,800	5,900	7.5	42,359	5.05	214,135.87	18.2	19.7	84.2	84.2
33	10,599	8,822	[a]11.1	[c]85,957						
34	7,004	5,046	7.0	35,133	5.50	[a]193,231.50	17.3	13.0		77.4
35	21,569	17,662	11.2	197,949	4.70	932,116.69				
36	18,327	17,690	[a]10.7	189,618						
37	5,036	4,192	8.9	37,219	4.50	167,650.66	15.7			78.7
38	3,800	3,500	[a]9.1	32,000	4.92	157,241.01	14.8		84.0	
39				18,750						
40				38,500						
41				17,888						
42	2,000	2,000	8.0	14,654	5.50	80,000.00	16.0		84.0	
Total and average			8.4	1,895,812	5.03		14.6	14.4	83.3	82.2

[a] Estimated. [b] Not working this year. [c] 11,648 tons shipped to another factory.

Factory and farm results for 1902—Continued.

Factory No.	Sugar.					Campaign.		
	Amount produced.		Average net selling price per hundredweight.	Seconds, beginning of campaign.	Seconds held for future campaign.	Opened.	Closed.	Number of days.
	Pounds.	Tons.						
				Pounds.	*Pounds.*			
1	3,206,782	1,603.39						
2	3,100,000	1,550.00	$4.38	20,000		Oct. 20,1902	Dec. 12,1902	54
3	5,460,000	2,730.00						
4	9,550,000	4,775.00				Oct. 10,1902	Jan. 28,1903	111
5	4,800,000	2,400.00						
6	14,481,135	7,240.57		100,351	84,906	Oct. 20,1902	Jan. 22,1903	95
7	5,600,000	2,800.00				Oct. 14,1902	Jan. 12,1903	91
8	9,300,000	4,650.00						
9	6,246,039	3,123.02	4.38	118,561	127,179	Oct. 13,1902	Jan. 6,1903	86
10	6,000,000	3,000.00						
11	936,103	468.05						
12	7,323,468	3,661.73	4.60			Oct. 9,1902	Jan. 21,1903	105
13	8,200,000	4,100.00				Oct. 8,1902	Jan. 9,1903	94
14	5,614,000	2,807.00						
15	9,500,000	4,750.00						
16	5,400,000	2,700.00						
17	2,441,674	1,220.84						
18	4,327,532	2,163.77						
19	6,500,000	3,250.00						
20	7,000,000	3,500.00						
21	7,613,500	3,806.75	4.51	374,000	528,000	Sept. 15,1902	Dec. 24,1902	101
22	29,529,700	14,764.85						
23	10,500,000	5,250.00						
24	6,777,100	3,388.55	4.28		22,105	Oct. 22,1902	Dec. 14,1902	54
25	8,000,000	4,000.00						
26	25,650,000	12,825.00				Sept. 27,1902	Jan. 19,1903	[a] 103½
27	8,885,800	4,442.90	4.75	107,000	118,000	Sept. 3,1902	Dec. 27,1902	116
28	7,830,300	3,915.15	4.75	73,800	150,900	Sept. 16,1902	Dec. 21,1902	97
29	20,802,000	10,401.00	4.39	1,508,533	2,225,173	Sept. 22,1902	Dec. 26,1902	96
30	12,848,000	6,424.00						
31 [b]								
32	10,153,500	5,076.75	4.02	115,624	83,129	July 27,1902	Nov. 4,1902	101
33	20,500,000	10,250.00						
34	10,032,580	5,016.29	3.97			Aug. 15,1902	Nov. 5,1902	83
35	43,214,000	21,607.00				Sept. 9,1902	Dec. 22,1902	105
36	53,336,500	26,668.25						
37	8,459,000	4,229.50				July 21,1902	Nov. 4,1902	107
38	8,706,372	4,353.19	4.55		1,919,000	Sept. 27,1902	Jan. 8,1903	104
39	3,750,000	1,875.00						
40	7,000,000	3,500.00						
41	4,560,000	2,280.00						
42	3,676,600	1,838.30	5.00			Sept. 22,1902	Dec. 10,1902	80
Total and average	436,811,685	218,405.85	4.46					94

[a] Of this time, 11½ days were lost.

[b] Not working this year.

Factory and farm results for 1902—Continued.

Factory No.[a]	Fuel used.						Limestone used.			Factory labor and wages.					
	Bituminous coal.		Coke.		Oil.					Common labor.			Skilled labor.		
	Amount.	Cost per ton.	Amount.	Cost per ton.	Amount.	Cost per barrel.	Amount.	Cost per ton.	Lime content.	Number employed for campaign.	Average daily wages.	Total amount paid.	Number employed for campaign.	Average daily wages.	Total amount paid.
	Tons.		*Tons.*		*Bbls.*		*Tons.*		*P. ct.*						
2	3,000	$3.00	75	$6.00	.....	.....	1,000	$1.40	.....	180	$1.50	$14,300	40	$2.50	$5,300
4	10,772	2.56	400	7.15	.....	.....	2,122	2.00	95.3	190	2.02	[b]42,602	14	.....	.....
6	13,074	2.64	739	.....	.....	.....	6,644	1.89	52.6	333	1.90	[b]60,106	47	2.80	69,152
7	[b]5,572	3.50	150	10.50	.....	.....	1,500	2.25	.....	.....	.....	.....	.....	.....	.....
9	5,097	2.65	223	4.75	.....	.....	1,611	2.52	97.0	107	1.75	21,453	11	3.00	10,652
12	10,632	3.12	264	5.05	.....	.....	[b]3,388	1.96	.....	300	[b]2.16	48,144	.....	.....	.....
13	8,700	2.55	262	5.14	.....	.....	2,049	2.05	96.0	214	1.69	33,634	39	3.10	11,244
21	8,896	2.50	616	7.15	.....	.....	5,395	1.70	40.0	250	2.00	49,098	.....	.....	.....
24	8,193	2.43	220	9.67	.....	.....	2,251	2.73	97.0	220	2.00	[b]23,760	20	4.00	[b]4,320
26	[c]27,000	[b]3.00	720	.....	.....	.....	6,870	[b]2.00	.....	365	[b]2.16	[b]81,599	.....	.....	.....
27	[b]8,452	2.56	169	16.25	.....	.....	1,706	1.87	.....	[b]90	1.80	[b]18,792	[b]10	2.50	35,280
28	6,097	2.50	166	15.50	.....	.....	1,706	1.68	90.6	120	2.00	9,519	.....	.....	24,302
29	12,991	3.25	460	16.00	.....	.....	4,781	2.25	95.0	300	2.00	[b]57,600	8	4.50	63,000
32	.....	.....	188	3.25	24,910	$0.52	2,296	2.35	98.0	130	2.25	29,548	13	3.15	4,136
34	.....	.....	248	12.00	35,825	.72	2,869	2.14	.....	170	2.10	28,917	45	3.50	12,757
37	.....	.....	238	14.13	24,679	.72	2,965	1.95	.....	95	1.96	19,852	49	2.64	13,959
38	7,750	3.06	185	8.09	.....	.....	1,645	1.75	95.0	150	1.92	[b]29,952	12	3.25	[b]4,056
42	3,000	5.25	118	11.65	.....	.....	1,082	2.73	.....	110	2.00	[b]17,600	10	4.00	[b]3,200
Average	.....	2.97	.....	9.52	.....	.65	.....	2.07	85.6	.....	1.95	.....	.....	3.24	.....

[a] In cases where factories failed to report data under these heads, the numbers are omitted.
[b] Estimated.
[c] Lignite.

Factory and farm results for 1902—Continued.

Factory No.[a]	Pulp.				Waste molasses.				Process used in treating molasses.
	Amount produced.	Amount sold.	Price per ton.	Sugar passed with cossettes.	Amount produced.	Content of sugar.	Amount sold.	Price per gallon.	
	Tons.	*Tons.*	*Cents.*	*P. ct.*	*Gallons.*	*P. ct.*	*Gallons.*	*Cents.*	
2	9,000	9,000	.....	0.38	13,000	48.0	13,000	.....	Crystallization.
4	.....	.....	.....	.35	.....	.....	.....	.....	Crystallization. Osmose.
6	Not weighed.	.....	Given away.	.28	135,000	49.8	.....	.....	Crystallization. Steffin.
9	23,221	.....	.....	.34	127,114	50.2	63,500	1	Crystallization.
12	.....	2,000	10	.....	[b]303,384	44.0	[b]303,384	1	Crystallization. Osmose.
13	35,000	.....	.....	.25	.....	.....	.....	.....	Crystallization.
21	.....	.....	.....	.57	.....	.....	.....	.....	Steffin.
24	14,000	14,000	30	.....	[b]198,133	50.0	.....	.....	Crystallization. Osmose.
27	20,000	20,000	50	.53	325,650	53.0	.....	.....	Crystallization.
28	11,000	11,000	50	.41	272,857	59.0	.....	.....	Grosse, Osmose.
29	35,000	15,000	30	.22	.....	.....	.....	.....	Crystallization. Osmose.
32	20,000	20,000	52	.95	635,000	52.8	73,959	2	Crystallization.
34	21,080	21,080	20	.44	201,690	43.3	201,690	16	Do.
37	.....	15,000	10	.48	.....	49.0	47,136	.....	
38	27,000	27,000	45	.....	[b]306,884	.....	[b]306,884	2	Do.
42	.....	.....	.....	1.00	.....	.....	.....	.....	Do.
Average	.....	.....	30	.48	.....	49.9	.....	4.4	

[a] Numbers of factories which did not report data coming under these heads are omitted.
[b] Estimated.

Factory and farm results for 1902—Continued.

Factory No.[a]	Largest average yield of beets per acre.							Price paid for beets.[b]		Freight rates, per ton, on beets.	Greatest quantity of beets worked in one day.
	Under any contract.				Under any contract of 10 acres or over.						
	Area.	Yield.	Sugar in beets.	Purity coefficient.	Yield.	Sugar in beets.	Purity coefficient.	Minimum or straight.	Additional scale.		
	Acres.	*Tons.*	*P. ct.*		*Tons.*	*P. ct.*		*Dollars.*	*Cents.*	*Cents.*	*Tons.*
2	2	24	13.0	84.0	20	13.5	84.0	5.00	.....	50	390
4	.....	.....	.....	.....	.....	.....	.....	4.50	33⅓	40 to 80	728
6	2	21	13.8	81.0	14	14.2	84.0	4.50	33⅓	40, 60, 80	1,178
7	.....	.....	.....	.....	.....	.....	.....	4.50	33⅓	.....	.....
9	1	17	13.5	.....	9	14.9	.....	4.50	33⅓	30 to 100	420
12	2	22	13.5	.....	14	14.5	.....	4.50	33⅓	.....	750
13	12	18	12.5	80.0	14	13.5	83.0	4.50	33⅓	40 to 60	.....
21	3	24	15.8	81.7	16	12.5	80.0	4.00	25	50 to 85	585
24	5	26	15.1	82.2	18	15.1	82.2	4.88	.....	30	685
26	15	32	.....	.....	.....	.....	.....	.....	.....	.....	.....
27	3	29	14.0	81.0	17	14.2	81.5	3.50	.....	35 to 50	350
28	2	20	.....	.....	20	16.0	87.7	4.50	.....	35	496
29	4	25	15.0	82.5	19	16.1	83.4	4.75	.....	100	1,175
32	2	35	19.0	84.0	10	18.0	84.0	3.00	25	Hauled.	755
34	.....	.....	.....	.....	.....	.....	.....	.....	.....	50 to 60	943
37	23	38	12.7	76.9	38	12.7	76.9	4.50	.....	30 to 55	510
38	2	22	15.2	84.6	16	14.0	83.5	4.85	.....	50 to 85	.....
42	5	14	.....	.....	10	.....	.....	.....	.....	50	270
Total and average	.....	.....	14.4	81.8	.....	14.6	82.7	4.40	31¼	.....	.....

[a] Numbers of factories which did not report data under these heads are omitted.
[b] At some factories a straight price per ton is paid for all acceptable beets; at others a minimum is fixed for beets having a certain percentage of sugar (usually 12 per cent), and an additional amount is paid for each additional 1 per cent of sugar in the beets.

In the table following (p. 118) appear several columns of very interesting data, not directly reported by the factories, but derived from the figures so reported. The most important data appearing in the preceding tables are repeated here in order to show clearly the source from which the other figures are derived.

Summary of factory results, with additional data derived therefrom.

Factory No.	Beet production.				Beets worked.		Coal used.		Fuel oil used.		Limestone used.		Ratio of materials to beets.[a]			Cost of working beets per ton.				Factory extraction of sugar.	Sugar produced.	
	Area planted.	Area harvested.	Average yield per acre.	Part of area harvested.	Amount.	Cost.	Amount.	Cost.	Amount.	Cost.	Amount.	Cost.	Coal.	Fuel oil.	Limestone.	Labor.	Coal.	Fuel oil.	Limestone.		Per acre.	Per ton of beets.
	Acres.	*Acres.*	*Tons.*	*P. ct.*	*Tons.*		*Tons.*		*Bbls.*		*Tons.*		*P. ct.*	*P. ct.*	*P. ct.*		*Cents.*	*Cents.*	*Cents.*	*P. ct.*	*Lbs.*	*Lbs.*
1					16,944															9.46		189
2	3,000	1,800	9.0	60.0	15,032	$83,050.00	3,000	$9,000			1,000	$1,400	20.0		6.7	$0.970	59.9		9.3	9.78	1,722	196
3					26,000															10.50		210
4	9,350	7,400	5.6	79.1	42,681	[b] 233,054.64	10,772	27,576			2,122	4,244	25.2		5.0	[b] .998	64.6		9.9	11.19	1,291	224
5					22,000															10.91		218
6	9,630	9,460	[b] 6.8	98.2	64,063	336,654.00	13,074	34,515			6,644	12,557	20.4		10.4	[b] .938	53.9		19.6	11.30	1,531	226
7	4,800	3,600	7.5	75.0	28,000	147,000.00	[b] 5,572	19,502			1,500	3,375	[b] 19.9		5.4		[b] 69.6		12.1	10.00	1,556	200
8	8,200	7,500	[b] 6.0	91.5	45,000															10.33	1,240	207
9	4,627	3,742	7.3	80.9	27,319	149,223.80	5,097	13,507			1,611	4,060	18.7		5.9	.785	49.4		14.9	11.43	1,669	229
10					30,000															10.00		200
11					4,676															10.01		200
12	5,500	5,000	7.5	90.9	38,499	201,323.98	10,632	33,172			[b] 3,388	[b] 6,640	27.6		[b] 8.8	1.251	86.2		[b] 17.2	9.51	1,465	190
13	7,000	6,000	6.5	85.7	39,900	200,610.94	8,700	22,185			2,049	4,200	21.8		5.1	.843	55.6		10.5	10.28	1,367	206
14		3,500	[b] 8.2		28,800															9.75	1,604	195
15	7,124	6,651	[b] 7.3	93.4	48,273															9.84	1,428	197
16	5,300	4,000	[b] 6.4	75.5	25,662															10.52	1,350	210
17					14,000															8.72		174
18	8,000	4,000	[b] 5.6	50.0	22,532															9.60	1,082	192
19					30,000															10.83		217
20					30,800															11.36		227
21	4,180	3,696	10.0	88.4	36,884	166,962.49	8,896	22,240			5,395	9,172	24.1		14.6	1.331	60.3		24.9	10.32	2,060	206
22					109,307															13.51		270
23					41,000															12.80		256
24	4,350	3,534	8.5	81.2	28,332	150,226.84	8,193	19,919			2,251	6,144	28.9		7.9	[b] .839	70.3		21.7	11.96	1,918	239
25					40,000															10.00		200
26	10,200	9,300	12.5	91.2	113,670	511,515.00	27,000	[b] 81,000			6,870	[b] 13,740	23.8		6.0	[b] .718	[b] 71.3		[b] 12.1	11.28	2,758	226
27	4,200	4,200	10.0	98.8	42,472	[b] 197,494.80	[b] 8,452	[b] 21,637			1,706	3,190	[b] 19.9		4.0	.442	[b] 51.0		7.5	10.46	2,116	209
28	5,500	4,672	8.0	84.9	35,856	168,232.93	6,097	15,242			1,706	2,866	17.0		4.8	.649	42.5		8.0	10.92	1,676	218
29	8,597	8,147	10.2	94.8	89,110	439,411.90	12,991	42,221			4,781	10,757	14.6		5.4	[b] .646	47.4		12.1	11.67	2,553	233
30	5,200	5,113	[b] 9.6	98.3	48,970															13.12	2,513	262
31[c]																						
32	6,800	5,900	7.5	86.8	42,359	214,135.87			24,910	$12,953	2,296	5,396		58.8	5.4	.698		30.6	12.7	11.99	1,721	240
33	10,599	8,822	[b] 11.1	83.2	[d] 85,957															11.92	2,324	238
34	7,004	5,046	7.0	72.0	35,133	193,231.50			35,825	25,973	2,869	6,141		102.0	8.2	.823		73.9	17.5	14.28	1,988	286

35	21,569	17,662	11.2	81.9	197,949	932,116.69	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10.92	2,447	218
36	18,327	17,690	[b] 10.7	96.5	189,618	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14.06	3,015	281
37	5,036	4,192	8.9	83.2	37,219	167,650.66	.....	.....	24,679	17,645	2,965	5,781	.....	66.3	8.0	.533	.....	47.4	15.5	11.36	2,018	227
38	3,800	3,500	[b] 9.1	92.1	32,000	157,241.01	7,750	23,715	.....	.....	1,645	2,879	24.2	.....	5.1	[b] .936	74.1	.....	9.0	13.60	2,488	272
39	.....	.....	.....	.....	18,750	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10.00	.....	200
40	.....	.....	.....	.....	38,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.09	.....	182
41	.....	.....	.....	.....	17,888	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.75	.....	255
42	2,000	2,000	8.0	100.0	14,654	80,000.00	3,000	15,750	.....	.....	1,082	2,954	20.5	.....	7.4	[b] 1.201	107.5	.....	20.2	12.54	1,838	251
Total and average	.....	.....	8.4	85.1	1,895,812	.....	.....	.....	.....	.....	.....	.....	21.8	75.7	6.9	.859	64.2	50.6	14.2	11.07	1,879	221

[a] The percentage figures in these columns simply express the ratio between the number of tons of beets on the one hand and the number of tons, barrels, or cords on the other.

[b] Estimated.

[c] Not working this year.

[d] 11,648 tons shipped to another factory.

The following table shows the best results achieved by farmers growing beets, as reported by 15 different factories. It shows the number of acres cultivated and the results. From the data given and other data available I have worked out the results achieved by the factories in working up the beets produced by these most successful growers.

Best crops of beets grown at 15 factories, and factory results with the same crops of beets.

Factory No.[a]	Beets.							Sugar.				
	Area.	Yield per acre.	Total crop.	Average price per ton.	Cash returns per acre.	Sugar in beets.	Purity coefficient.	Factory extraction.	Per ton of beets.	Per acre.	Average price per pound.	Value per acre.
	Acres.	*Tons.*	*Tons.*			*P. ct.*		*P. ct.*	*Lbs.*	*Lbs.*	*Cents.*	
2	2	24	48	$5.50	$132.00	13.0	84.0	9.78	196	4,704	4.38	$206.04
6	2	21	42	5.25	110.25	13.8	81.0	11.30	226	4,746	.....	.....
9	1	17	17	5.46	92.82	13.5	[b] 85.1	11.43	229	3,893	4.38	170.51
12	2	22	44	5.39	118.58	13.5	.....	9.51	190	4,180	4.60	192.28
13	12	18	216	5.03	90.54	12.5	80.0	10.28	206	3,708	.....	.....
21	3	24	72	4.53	108.72	15.8	81.7	10.32	206	4,944	4.51	222.97
24	5	26	130	5.00	130.00	15.1	82.2	11.96	239	6,214	4.28	265.96
26	15	32	480	4.50	144.00	[b] 15.4	[b] 84.8	11.28	226	7,232	.....	.....
27	3	29	87	4.65	134.85	14.0	81.0	10.46	209	6,061	4.75	287.90
28	2	20	40	4.50	90.00	[b] 14.8	[b] 84.4	10.92	218	4,360	4.75	207.10
29	4	25	100	4.93	123.25	15.0	82.5	11.67	233	5,825	4.39	255.72
32	2	35	70	5.05	176.75	19.0	84.0	11.99	240	8,400	4.02	337.68
37	23	38	874	4.50	171.00	12.7	76.9	11.36	227	8,626	.....	.....
38	2	22	44	4.92	108.24	15.2	84.6	13.60	272	5,984	4.55	272.27
42	5	14	70	5.50	77.00	[b] 16.0	[b] 84.0	12.54	251	3,514	5.00	175.70
Average	.....	.....	.....	4.98	120.53	14.8	82.6	11.42	228	5,493	4.46	235.83

[a] The factory numbers are the same here as in the previous tables.
[b] The figures for these beets not being available, the averages given in table on page 114 are used.

The following table is interesting as showing the development of the industry in the various States. It will be seen from this that California is considerably in the lead, while Michigan, Colorado, and Utah occupy second, third, and fourth places, respectively.

Beets worked and sugar produced in 1902, by States.

State.	Amount of beets worked.	Amount of sugar produced.	
		Pounds.	Tons.
	Tons.		
New York	32,606	6,271,248	3,135.57
Michigan	507,408	105,179,951	52,589.91
Nebraska	97,684	21,113,500	10,556.75
Colorado	332,309	80,456,800	40,218.40
Utah	167,438	37,518,100	18,759.05
California	637,204	158,543,580	79,271.79
Minnesota	32,000	8,706,372	4,353.18
Ohio	18,750	3,750,000	1,875.00
Wisconsin	38,500	7,000,000	3,500.00
Oregon	17,888	4,560,000	2,280.00
Washington	14,654	3,676,600	1,838.30

MISCELLANEOUS SUGAR STATISTICS.

The following tables, except the last, which contains the sugar crops of the world, were compiled by the Division of Foreign Markets, Department of Agriculture. These tables present some very interesting data touching the production and consumption of sugar; also information as to imports of sugar into the United States, and the average prevailing price of sugar during 1902.

Production of beet and cane sugar in the United States.[a]

Year.	Beet.	Cane (Louisiana).	Total.[b]
	Tons.[c]	*Tons.*[c]	*Tons.*[c]
1883-84	535	128,443	128,978
1884-85	953	94,376	95,329
1885-86	600	127,958	128,558
1886-87	800	80,859	81,659
1887-88	255	157,971	158,226
1888-89	1,861	144,878	146,739
1889-90	2,203	130,413	132,616
1890-91	3,459	215,844	219,303
1891-92	5,356	160,937	166,293
1892-93	12,018	217,525	229,543
1893-94	19,950	265,836	285,786
1894-95	20,092	317,334	337,426
1895-96	29,220	237,721	266,941
1896-97	37,536	282,069	319,545
1897-98	40,398	310,313	350,711
1898-99	32,471	248,658	281,129
1899-1900	72,972	142,485	215,457
1900-1901	76,859	270,338	347,197
1901-2	163,126	310,000	473,126
1902-3	195,463	280,000	475,463

[a] Data as to beet sugar are obtained from the following sources: For 1899-1900, from the Eleventh Census; for 1897-98, from a special report of the Department of Agriculture; and for other years, from Willett & Gray. Data as to cane sugar are from the following sources: For 1889-90, 1898-99, and 1899-1900, from the Eleventh and Twelfth censuses; for 1901-2 and 1902-3, from Willett & Gray; for other years, from Bouchereau's Annual Louisiana Sugar Reports (the figures for 1892-93 being taken from his revised statement).

[b] These figures do not include cane sugar produced outside of Louisiana; in 1889-90 such sugar amounted to 4,089 tons and in 1899-1900, to 1,510 tons.

[c] Tons of 2,240 pounds.

Production of cane sugar in dependencies of the United States for the crop years 1898-99 to 1902-3.[a]

Dependency.	1898-99.	1899-1900.	1900-1901.	1901-2.	1902-3.
	Tons.[b]	*Tons.*[b]	*Tons.*[b]	*Tons.*[b]	*Tons.*[b]
Hawaii	252,506	258,521	321,461	317,509	349,000
Porto Rico	53,825	35,000	80,000	85,000	85,000
Philippine Islands	93,000	62,785	55,400	78,637	80,000
Total	399,331	356,306	456,861	481,146	514,000

[a] According to estimates of Willett & Gray; the statistics given for the Philippine Islands are export returns and not production returns.

[b] Tons of 2,240 pounds.

Imports of sugar into the United States, 1883–1902.

Year ended June 30—	Pounds.	Tons.[a]	Value.
1883	2,137,819,123	954,384	$91,637,992
1884	2,756,416,896	1,230,543	98,262,607
1885	2,717,884,653	1,213,341	72,519,514
1886	2,689,881,765	1,200,840	80,773,744
1887	3,136,443,240	1,400,198	78,411,224
1888	2,700,284,282	1,205,484	74,245,206
1889	2,762,202,967	1,233,126	88,543,971
1890	2,934,011,560	1,309,827	96,094,532
1891	3,483,477,222	1,555,124	105,728,216
1892	3,556,509,165	1,587,727	104,408,813
1893	3,766,445,347	1,681,449	116,255,784
1894	4,345,193,881	1,939,819	126,871,889
1895	3,574,510,454	1,595,764	76,462,836
1896	3,896,338,557	1,739,437	89,219,773
1897	4,918,905,733	2,195,940	99,066,181
1898	2,689,920,851	1,200,858	60,472,749
1899	3,980,250,569	1,776,898	94,964,120
1900	4,018,086,530	1,793,789	100,250,974
1901[b]	4,803,088,500	2,144,236	122,276,999
1902[b]	3,936,286,281	1,757,271	84,871,299

[a] Tons of 2,240 pounds.

[b] As in earlier years, including shipments from Hawaii and Porto Rico to the United States. For 1901 the shipments from Hawaii amounted to 690,880,832 pounds, or 308,429 tons, valued at $27,094,095, and from Porto Rico 137,201,828 pounds, or 61,251 tons, valued at $4,695,104. For 1902 the shipments from Hawaii amounted to 720,553,357 pounds, or 321,676 tons, valued at $23,920,113, and from Porto Rico 183,817,049 pounds, or 82,061 tons, valued at $5,890,089.

Consumption of sugar in the United States, 1893–1902.

Calendar year.	Total amount of sugar consumed.[a]	Increase (+) or decrease (−) as compared with previous year.		Consumption per capita.
	Tons.[b]	*Tons.*[b]	*Per cent.*	*Pounds.*
1883	1,170,375	+109,155	+10.29	48.83
1884	1,252,366	+ 81,991	+ 7.01	51.09
1885	1,254,116	+ 1,750	+ .14	50.03
1886	1,355,809	+101,693	+ 8.11	52.91
1887	1,392,909	+ 37,100	+ 2.74	53.17
1888	1,457,264	+ 64,355	+ 4.62	54.43
1889	1,439,701	− 17,563	− 1.21	52.62
1890	1,522,731	+ 83,030	+ 5.77	54.47
1891	1,872,400	+349,669	+22.96	65.69
1892	1,853,370	− 19,030	− 1.02	63.79
1893	1,905,862	+ 52,492	+ 2.83	64.34
1894	2,012,714	+106,852	+ 5.61	66.66
1895	1,949,744	− 62,970	− 3.13	63.36
1896	1,940,086	− 9,658	− .50	61.86
1897	2,070,978	+130,892	+ 6.75	64.80
1898	2,002,902	− 68,076	− 3.29	61.50
1899	2,078,068	+ 75,166	+ 3.75	62.63
1900	2,219,847	+141,779	+ 6.82	65.17
1901	2,372,316	+152,469	+ 6.87	68.44
1902	2,566,108	+193,792	+ 8.17	72.76

[a] According to Willett & Gray.

[b] Tons of 2,240 pounds.

Average import price per pound of sugar imported into the United States. [a]

Year ended June 30—	Raw sugar (not above No. 16 Dutch standard).						Refined sugar. [c]
	Beet.	Cane—				Average for all raw sugar. [b]	
		From Hawaii.	From Porto Rico.	From Cuba.	From other countries.		
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1892	2.8	2.8	2.9	3.1	2.7	2.9	3.8
1893	2.9	2.9	3.2	3.3	2.8	3.1	3.9
1894	3.1	2.9	3.2	3.0	2.7	2.9	3.8
1895	2.0	2.7	1.8	2.2	1.9	2.1	2.8
1896	2.3	3.2	2.1	2.2	2.1	2.3	2.9
1897	1.8	3.1	1.8	2.1	1.9	2.0	2.5
1898	1.9	3.3	1.9	2.2	1.9	2.2	2.4
1899	2.1	3.7	2.3	2.5	2.1	2.4	2.7
1900	2.1	4.0	3.4	2.6	2.2	2.5	3.4
1901	2.2	3.9	3.4	2.4	2.2	2.5	2.7
1902	1.6	3.3	3.2	1.8	1.8	2.2	2.4

[a] Based on official returns published by the Bureau of Statistics, Treasury Department. These figures represent the wholesale market prices at the ports of shipment, and do not include the import duty levied in this country nor the cost of transportation to this country.

[b] For 1901 and 1902, as in previous years, including imports from Hawaii and Porto Rico, as well as from foreign countries. The average price of raw sugar imported from foreign countries was 2.3 cents in 1901 and 1.8 cents in 1902.

[c] Including raw sugar above No. 16 Dutch standard.

Average market price of sugar per pound in New York City. [a]

Calendar year.	89° muscovado.	96° centrifugal.	Granulated.
	Cents.	*Cents.*	*Cents.*
1892	2.8	3.3	4.3
1893	3.2	3.7	4.8
1894	2.6	3.2	4.1
1895	2.9	3.3	4.2
1896	3.2	3.6	4.5
1897	3.1	3.6	4.5
1898	3.7	4.2	5.0
1899	3.9	4.4	4.9
1900	4.0	4.6	5.3
1901	3.5	4.0	5.1
1902	3.0	3.5	4.5

[a] According to statistics published by Willett & Gray, of New York City.

Sugar crops [a] *of the world for four years.* [b]

Grand division and country.	1899–1900.	1900–1901.	1901–2.	1902–3.
CANE SUGAR.				
United States:	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Louisiana	147,164	270,338	310,000	280,000
Porto Rico	35,000	80,000	85,000	85,000
Hawaiian Islands	258,521	321,461	317,509	349,000
Cuba	308,543	635,856	850,181	975,000
British West Indies:				
Trinidad, exports	42,210	52,673	51,077	50,000
Barbados, exports	50,000	55,360	43,750	34,000
Jamaica, exports	19,510	17,059	15,843	18,772
Antigua and St. Kitts	15,052	21,579	19,000	18,000
French West Indies:				
Martinique, exports	30,000	39,750	34,942	28,000
Guadeloupe	40,000	39,000	41,000	41,000
Danish West Indies—St. Croix	12,020	13,000	13,000	13,000
Haiti and Santo Domingo	45,000	45,000	45,000	45,000
Lesser Antilles, not named above	8,000	8,000	8,000	8,000
Mexico	78,000	95,000	103,110	115,000
Central America:				
Guatemala	12,000	9,000	10,000	10,000
San Salvador	5,000	5,000	5,000	5,000
Nicaragua	4,000	3,500	4,500	4,500
Costa Rica	4,000	4,000	4,000	4,000

[a] In a number of cases statistics of exports are given, this being indicated.

[b] Statistics of Willett & Gray, except estimate of beet-sugar production in Europe by Licht.

Sugar crops of the world for four years—Continued.

Grand division and country.	1899–1900.	1900–1901.	1901–2.	1902–3.
CANE SUGAR—continued.				
South America:	*Tons.*	*Tons.*	*Tons.*	*Tons.*
British Guiana (Demerara), exports	90,079	84,559	123,967	105,000
Dutch Guiana (Surinam)	9,600	13,000	12,750	13,000
Venezuela	2,000	3,000	3,000	3,000
Peru	125,000	135,000	138,000	140,000
Argentine Republic	91,507	114,252	135,000	130,000
Brazil	322,000	320,000	345,000	187,500
Total in America	1,754,206	2,385,387	2,718,629	2,661,772
Asia:				
British India, exports	10,000	15,000	15,000	15,000
Siam	7,000	7,000	7,000	7,000
Java	721,993	709,928	767,130	842,812
Japan	2,000			
Philippine Islands, exports	62,785	55,400	78,637	80,000
Total in Asia	803,778	787,328	867,767	944,812
Australia and Polynesia:				
Queensland	124,070	92,554	120,858	76,626
New South Wales	15,500	19,000	18,000	18,000
Fiji Islands, exports	31,000	33,000	31,000	35,000
Total in Australia and Polynesia	170,570	144,554	169,858	129,626
Africa:				
Egypt	98,500	94,880	96,200	90,000
Mauritius	157,025	175,267	147,828	135,000
Reunion	35,000	35,000	35,000	35,000
Total in Africa	290,525	305,147	279,028	260,000
Europe—Spain	33,215	28,000	28,000	28,000
Total cane-sugar production	3,052,294	3,650,416	4,063,282	4,024,210
BEET SUGAR.				
Europe (Licht)	5,518,048	6,046,518	6,820,733	5,605,000
United States	72,944	76,859	163,126	195,463
Total beet-sugar production	5,590,992	6,123,377	6,983,859	5,800,463
Grand total cane and beet sugar	8,643,286	9,773,793	11,047,141	9,824,673

SELECTED FARM RESULTS FOR 1902 SHOWING POSSIBILITIES IN BEET GROWING.

To show what it is possible for farmers to accomplish in growing sugar beets, I offer some tables showing the best results obtained by the farmers at the different factories. These do not of course indicate the average results.

AN ILLUSTRATION FROM NEBRASKA.

I have been very much interested during the past year in an experiment at Fremont, Nebr. There is no factory at this place, but there is one at Leavitt, about 11 miles west of Fremont. The business men of the town thoroughly appreciate the advantages growing out of sugar-beet culture in this vicinity. This is the junction point of railroads, which facilitates the delivery of beets to any one of the three factories in Nebraska. For some time it has been the purpose

of those interested in the welfare of the town to eventually establish a beet-sugar factory there. In order to demonstrate to the farmers the practical results of growing sugar beets, a certain number of business men organized the Fremont Sugar-Beet Company. This company rented 150 acres of land, paying therefor $5 per acre, cash rent. This land was planted to beets, and after the crop was delivered to the factory a statement was made for the benefit of those interested in the enterprise, showing the results as follows:

Financial statement of Fremont Sugar-Beet Company for 1902.

Receipts:		
Capital stock		$3,850.00
Beets, 1,749.58 tons, at $4		6,998.33
Beet tops		41.00
Total		10,889.33
Disbursements:		
Labor	$4,352.18	
Seed and freight	448.61	
Land rent	750.80	
Machinery	248.50	
Incidentals and repairs	60.91	
Total		5,861.00
		5,028.33
Deduct capital stock		3,850.00
Net profit		1,178.33

We take great pleasure in presenting to you, as stockholders in the Fremont Sugar-Beet Company, the above statement of the company's financial standing for this year; and we hope that the profit therein shown will in a measure compensate those who have been faithful and persistent in fostering this young but beneficial industry.

We also hope that the flattering results of this year's work will quiet the fears of any who might still be skeptical as to this industry being made a success in our locality.

We may therefore look for more uniform results in coming years than we have had in the past.

And last, but not least, the experience gained in the past will prove of great service in the future.

A. S. Grigereit,
W. A. Carroll,
Frank Hammond,
Committee.

One interesting feature about the above report is the fact that everything done was hired. The parties interested in this company were business men. A man thoroughly acquainted with growing beets was employed to superintend the job.

The above statement is a remarkable showing of the practical results of beet-sugar growing from an investment standpoint. This company after paying all expenses had a full equipment of necessary

farm implements on hand valued at $248, less a fair allowance for wear and tear. In addition, it had a balance in its treasury of $215.82 after declaring a dividend of 25 per cent.

The following deductions are made by myself from the data contained in the report of the company:

The average yield of these 150 acres was 11.67 tons of beets per acre. The gross receipts were $46.68 per acre. The cost of producing the beets, including the rent of the land, was $37.58 per acre. The net returns from the crop of beets were $9.10 per acre. If no rent had been paid for the land, the net returns would have been $14.10 per acre.

An idea of the comparative profitableness of the beet-sugar crop can be obtained by comparing the above figures of net returns with with the average gross returns obtained by farmers who raise grain. The crop statistics for 1902 collected by the United States Department of Agriculture show that the average gross values per acre of the principal cereal crops for the entire country were as follows: Corn, $10.81; wheat, $9.14; oats, $10.60; and barley, $13.28.

It will be noticed that the tonnage of beets produced at Fremont is not remarkably large, nor is the cost of production as low as the estimated average for sugar-beet crops. Yet it may well be doubted if these same parties could have found any other investment from which they could have gotten larger legitimate dividends than they secured from growing these sugar beets.

The important thing, and the thing that is absolutely necessary to the success of a sugar factory, is beets. There is hardly a factory in the country to-day that has been able to purchase a sufficient supply of beets to meet the requirements of a full campaign. This report of the Fremont Sugar-Beet Company should stimulate business men as well as farmers to undertake the growing of sugar beets not merely as a profitable investment, but as a means of sustaining an industry which does so much for the prosperity of the whole community.

SOME FARM RESULTS IN MINNESOTA FOR 1902.

During the campaign of the Minnesota Sugar Company last fall I called at the factory and was shown by the manager, Mr. Fink, some of the individual accounts with the farmers.

These accounts showed (1) the gross weight of beets, (2) the amount of tare, (3) net weight of the beets, (4) gross amount and value of total crop, (5) a statement of freight showing the factory's share and the farmer's share, (6) the charges of the factory for the use of different implements, (7) total amount of seed used, (8) total amount deducted for seed, and (9) the net amount to be forwarded to the farmer.

It occurred to me that a reproduction of a limited number of these

accounts might be quite interesting to those investigating the results of sugar-beet growing. Mr. Fink offered to furnish me copies of as many of them as I desired, and I asked for 25 of his best. From these I have compiled the table below. It should be kept in mind that these are not average results, but the best results obtained at that factory during the campaign of 1902, the object being to show the possibilities of growing sugar beets under ordinary circumstances.

Accounts of 25 successful beet growers in Minnesota in 1902.

Grower's name and address.	Number of acres.	Gross weight of beets.	Tare.	Net weight of beets.		Gross value.	Freight charges.		Rent of implements.	Seed used.		Net amount of check.
				Pounds.	Tons.		Factory's share.	Farmer's share.		Amount.	Value.	
		Lbs.	*P. ct.*							*Lbs.*		
P. Fortin, Hamel	2	83,060	8	77,165	38.53	$175.86	$12.25	$7.75	$1.00	36	$5.40	$161.71
T. Schwalbe, Waconia	5	156,482	10	140,842	70.42	316.90	27.37	11.75	.....	72	9.45	295.70
D. Stockmann, Plato	2	72,055	7⅘	66,395	33.19	149.37	12.60	9.33	1.25	36	5.40	133.30
N. N. Waylander, Grove City	3	124,650	8⅘	113,615	56.81	255.63	21.81	25.28	2.00	108	16.20	211.55
Nels. M. Okeson, Grove City	2	76,410	7	71,155	35.58	160.10	13.37	17.17	1.50	36	5.40	136.03
Geo. Dimler, Chanhassen	2	92,500	6	86,855	43.43	195.49	16.18	6.95	1.00	36	5.40	182.14
O. E. Stromberg, Buffalo	2	74,860	6	70,370	35.19	158.33	13.10	12.79	1.00	36	5.40	139.14
W. Luehring, Hamburg	3	176,210	9⅕	159,680	19.84	359.27	30.83	22.02	2.25	90	13.50	321.50
J. Martin, Owatonna	1	38,150	6½	35,670	17.84	80.26	6.68	6.67	.75	18	2.70	70.14
W. Herman, Heidelberg	1	45,700	7	42,500	21.25	95.62	8.00	5.71	.75	18	2.70	86.46
Aug. Henschke, Arlington	1	36,220	10	32,600	16.30	73.35	6.34	6.33	.75	18	2.70	63.57
F. Wickenhauser, jr., Cologne	1	41,450	5	39,380	19.69	88.60	7.25	5.18	.....	18	2.70	79.47
Thos. Kasperek, New Prague	2	72,900	7½	67,435	33.72	151.73	12.76	9.11	1.50	36	5.40	135.72
Mrs. Sebilla Van Horrik, Glencoe	3	96,390	7⅘	88,855	44.33	199.92	16.87	12.05	2.00	54	8.10	177.77
Aug. Cohrs, Glencoe	1½	56,240	7	52,305	26.15	117.67	9.84	7.03	.75	27	4.05	105.84
Daniel Danielson, Dassel	2	87,865	6¾	81,935	40.97	184.35	15.37	19.77	1.50	36	5.40	156.90
John Almquist, Dassel	1	42,290	5¾	39,850	19.93	89.66	7.40	9.51	.75	24	3.60	75.80
Carl Ponath, Young America	2	80,400	10	72,360	36.18	162.81	14.07	10.05	1.50	36	5.40	145.86
John Dietel, Young America	2	67,630	9⅖	61,290	30.64	137.89	11.83	8.46	1.50	36	5.40	122.53
Frank Treka, Montgomery	2	88,970	.....	80,270	40.14	180.60	15.57	11.12	1.25	36	5.40	162.83
Frank Kukachaka, Montgomery	3	126,180	10	113,565	56.78	255.52	22.09	15.76	2.00	64	9.60	228.16
Thos. Choudeck, Montgomery	2	107,810	8⅖	98,785	49.39	222.27	18.87	13.48	1.50	84	8.10	199.19
Jacob Ectek, Montgomery	1½	56,630	8	52,100	26.05	117.22	9.91	7.08	.75	21	3.15	106.24
Johann Melchert, Waconia	1½	48,970	10	44,073	22.04	99.16	8.57	3.67	.60	27	4.05	90.84
Geo. Buaernschmitt, Waconia	2	77,950	9⅖	70,410	35.21	158.41	13.64	5.85	1.50	36	5.40	145.66

This table reveals several interesting things, among others that the amount of tare or dirt adhering to beets as ordinarily delivered to the factory runs from about 5 to 10 per cent. The tare in a factory depends

largely upon the character and conditions of the soil. Certain kinds of clay will adhere more largely than will sandy soil. Some soil will adhere to the beets more if the ground be wet and muddy than if it be dry. The percentage of tare shown in this table is probably a fair average for the factories in all sections, although in extreme cases it runs up as high as 25 per cent.

The average cost of producing an acre of sugar beets at this factory is about $30. From this table anyone can easily calculate the net returns per acre which the 25 farmers secured. They are as follows:

1	$57.93	14	$36.64
2	33.38	15	48.44
3	44.68	16	62.17
4	55.21	17	59.66
5	50.50	18	51.40
6	67.74	19	38.94
7	49.16	20	60.30
8	89.75	21	55.17
9	50.26	22	81.13
10	65.62	23	63.77
11	43.35	24	36.10
12	58.60	25	49.20
13	45.86		

SOME FARM RESULTS IN COLORADO IN 1902.

Below I give a table furnished by the management of the American Beet Sugar Company to a Colorado paper, giving a detailed account of the farm results of all the producers growing sugar beets for the factory at Rockyford, Colo. In this table are given the gross amounts received by 22 farmers whose receipts were more than $100 per acre. There is also given the number of farmers receiving from $40 to $50, from $50 to $60, from $60 to $70, from $70 to $80, from $80 to $90, and from $90 to $100 per acre, respectively. All beets worked at this factory are grown by the aid of irrigation.

The following is clipped from the Independent, Littleton, Colo.:

The American Beet Sugar Company furnishes us the following figures showing the results of the campaign just closed. The figures which show up the agricultural resources of the valley to the best advantage are those which give the names and amounts of cash received by the most successful growers. The table below and the synopsis following it make a showing for farming profits hard to beat, either in the East or in the West:

Total quantity of beets received	tons	113,361
Average sugar content of beets received	per cent	17.19
Average price paid for beets received		$5.00
Sugar made, including osmose	pounds	29,500,000

The following parties received for beets over $100 per acre:

A. J. Gillock, Deerfield, Kans	$133.06
C. T. Kouns, Rockyford, Colo	129.48
E. F. Kelso, Rockyford, Colo	126.75

J. L. Bennett, Rockyford, Colo	$123.62
Henry Entz, Lakin, Kans	119.60
J. C. Whittaker, Rockyford, Colo	114.98
William Morrison, La Junta, Colo	113.57
Francis McCormick, Rockyford, Colo	112.62
L. C. Swink, Rockyford, Colo	111.10
William Crabb, Rockyford, Colo	110.24
J. W. Belew, Rockyford, Colo	109.57
James Piper, Rockyford, Colo	109.00
William Waters, La Junta, Colo	108.80
L. M. Kell, Deerfield, Kans	105.24
T. A. Eavis, Manzanola, Colo	104.81
Carl Coerber, Lakin, Kans	103.90
C. J. Cover, Lakin, Kans	103.40
J. P. Mulloney, Rockyford, Colo	102.30
J. A. Keithly, Rockyford, Colo	102.20
William B. Ebbart, Rockyford, Colo	101.20
A. P. Kouns, Rockyford, Colo	100.80
Joseph Gill, Powers, Colo	100.33

Number of growers receiving—

Over $100 per acre	22
From $90 to $100 per acre	17
From $80 to $90 per acre	49
From $70 to $80 per acre	61
From $60 to $70 per acre	103
From $50 to $60 per acre	143
From $40 to $50 per acre	187

SOME FARM RESULTS IN MICHIGAN IN 1902.

The following table shows the results obtained by 15 of the most successful farmers at Lansing, Mich. It is given for the same purpose as the similar statements which precede it, viz., to show the possibilities:

Results achieved by 15 beet growers near Lansing, Mich.

Name and address of grower.	Area harvested.	Average yield per acre.	Weight of beets harvested free from dirt.		Cash receipts for crop.[a]	Cash receipts per acre.
			Pounds.	Tons.		
	Acres.	*Tons.*				
C. C. Allen, Lansing, No. 5	10	10.19	203,941	101.97	$530.14	$53.01
Otto Felzke, Delta	4	10.20	83,662	41.83	209.21	52.30
W. J. Waller, Bath	2	21.08	84,328	42.16	213.06	106.53
Jas. Cortwright, N. Lansing	3	13.60	81,627	40.81	106.05	85.35
Clark Smith, Grand Ledge	2	15.66	62,676	31.33	167.16	83.58
G. Schray, Lansing, No. 4	16	11.61	371,586	185.79	952.02	59.50
H. J. Henderson, Lansing, No. 1	4	12.27	98,216	49.10	260.47	66.62
E. P. Rowe, Mason	6	16.05	192,643	96.32	453.70	75.62
W. R. Quantrell, Charlotte	10	10.96	219,354	109.67	522.29	52.23
J. W. Wheeler, Portland	2	12.37	49,517	24.75	115.26	57.63
Noah Porter, Williamston	2	10.68	42,728	21.36	105.07	52.53
Lewis Dunn, Shaftsbury	2	14.22	56,913	28.45	123.40	61.70
G R. and L. E. Ling, Webberville	4	13.80	110,409	55.20	270.91	67.73
W. J Davis, Bismarck	2	17.77	71,098	35.54	164.51	82.25
E. H. Hume, Lansing, No. 1	20	9.89	394,945	197.47	1,011.41	50.57

[a] This column shows the amounts which the farmers received for the beets after charges for seed and transportation had been deducted.

AGRICULTURAL CONDITIONS, FARM RESULTS, AND RELATIONS BETWEEN THE FACTORIES AND THE FARMERS.

In order to bring out some interesting information touching farm conditions and results, I wrote to each of the sugar factories of the United States, asking for a report from the agriculturist as to the season, results of beet growing, different factory relations with the farmer, kinds of implements and seed used, disposition of pulp, etc.

As it appeared from several of these communications that the manufacturing companies preferred that they be treated as more or less confidential, I withhold the names of the factories, simply indicating the locality of each, and submitting the information for what it is worth, believing the reports contain much valuable information.

The letter of inquiry sent out is given first, and is followed by the replies:

DES MOINES, IOWA, *February 2, 1902.*

DEAR SIR: In order to present intelligently to the Government, and through it to the people of the United States, the facts and conditions underlying the progress of the beet-sugar industry, I feel the necessity of furnishing the actual results, conditions, and experiences at the factories themselves.

Below I give a list of inquiries, which I presume could be answered best by the agriculturist. Will you not kindly hand this letter over to the proper person, with a request that a report for 1902 be furnished me along the lines indicated below, numbering each reply to correspond with the topic.

(1) The general favorable or unfavorable conditions of the season (1902) at different times, with effect.
(2) Price paid for beets.
(3) Number of acres planted.
(4) Tons of beets worked at factory.
(5) Methods of determining tare.
(6) Your system of dumps and cost of unloading per ton.
(7) Kinds of harvesters, and experience with them.
(8) Average yield of beets per acre.
(9) Values of lands and rents.
(10) Cost of producing beets.
(11) Labor, kind, cost, and supply.
(12) Seed, kind and cost to farmer; amount used per acre; home grown or foreign.
(13) How many times are beets hoed, cultivated, and irrigated?
(14) Freight charges on beets.
(15) Number of contracting farmers.
(16) Do you produce sugar-beet seed? If so, how much?
(17) Pulp feeding, price of pulp, and its popularity.
(18) Amount of pulp produced and disposition made of it.
(19) Stock feeding, dairying, etc., in your vicinity.
(20) Rotation of crops.
(21) Kind of ground, soil, and preceding crop.

I have asked the Department to forward you my last report.

Respectfully,

C. F. SAYLOR,
Special Agent in Charge of Sugar Investigations.

REPORT FROM A MICHIGAN FACTORY.

(1) Our season the past year was wet from start to finish. The seed never sprouted on some of the patches on account of being under water, and many beets were never pulled because the ground was too wet to get on and work. This, of course, decreased the yield to a great extent. Take it all in all, the season was a very unfavorable one for a good crop.

(2) We paid the farmers the regulation Michigan price for beets, $4.50 per ton for 12 per cent beets, and 33⅓ cents added or deducted for each per cent above or below 12 per cent. The highest price paid was $6.57 per ton, the average price $5.13, and the lowest $3.14.

(3) We had nearly 4,700 acres on our books, some of which, however, was never planted on account of the wet weather.

(4) Our net washed beets amounted to 27,242 tons for the season, the average tare being 11.6 per cent.

(5) In determining the tare, we use the washing by water method. Frozen beets, or beets with frozen soil on them, are washed in warm water, and afterwards dried, topped, and then weighed back. The topping is done with a knife, topping each beet singly.

(6) We have no regular system of dumps, all beets being unloaded by hand, both from cars and wagons. For unloading the beets received in cars we pay 8 cents per ton. This work goes to one man under contract.

(7) The only harvester that is used here is a patented beet puller, which works very satisfactorily as far as it goes. All it does, however, is to lift the beets. They are then topped on the field by hand.

(8) The beets averaged no more than 6 to 7 tons per acre, being just about one-half a crop.

(9) The value of land and the rent of the same are very hard to get at. Prices have, of course, risen very much since the industry started here. Some exceptional pieces of land are renting as high as $20 per acre, but the usual rent is somewhat lower, ranging from $5 to $15 per acre.

(10) We usually figure the cost of producing at from $15 to $30 per acre, dependent, of course, upon the nature of the land, nearness to the city, etc.

(11) The labor in our vicinity is entirely domestic. Up to this time we have imported none. For the past two or three years it has been very hard to get, so many of the laborers have been flocking to the towns, preferring, it seems, factory work. Last year some of the farmers paid as high as $1.25 to $1.50 per day and board. The usual price, however, is from $20 to $40 per month.

(12) We used last year only two kinds of seed, Hoerning's Improved Kleinwanzlebener and R. & G.'s Original Kleinwanzlebener. This costs the farmers 15 cents per pound, which amount we deduct from their first delivery of beets in the fall. They use from 10 to 16 pounds per acre, depending upon the soil, the heavy clay soils seeming to need more than the sandy soils. We use no domestic seed at all.

(13) We use no irrigation whatever.

(14) Freight charges: From 1 to 25 miles, 30 cents per ton; from 25 to 50 miles, 50 cents per ton; from 50 to 60 miles, 60 cents per ton; from 60 to 75 miles, 70 cents per ton. The above are the rates when the beets are delivered by one road. When the beets are shipped over two roads, the rates are nearly doubled for the same distance.

(15) We had on our books this year 1,833 contractors.

(16) We produce no sugar-beet seed.

(17) Pulp feeding has not been very popular in this immediate vicinity, especially the past season, as the nice late fall gave the farmers lots of grazing, and they did not care to haul pulp while they could keep their cattle on grass. After snow came there seemed to be no trouble in getting the farmers to take it. The beet raisers got

it for hauling, and those living at a distance got it for the freight charges, which are the same as they are on beets.

(18) We produced last year about 23,000 tons of wet pulp. Of this we shipped about one-tenth by rail, the farmers hauled away about one-third, and the rest was "turned under" on adjoining vacant property.

(19) There is very little stock raised here, but considerable dairying.

REPORT FROM ANOTHER MICHIGAN FACTORY.

(1) During the time for preparing the land, planting, and germination of the seed, the season was very favorable, but during the cultivating and harvesting it was very unfavorable on account of excessive rains, making a low tonnage on level lands that were not thoroughly underdrained by causing the beets to be small. The higher and more rolling grounds that were surface-drained gave the best results.

(2) The average price of beets was $5.40.

(3) The number of acres planted was 5,500.

(4) The number of tons of beets worked at the factory was 38,499.

(5) In determining tare, we select 20 pounds of beets, wash, trim, and weigh again.

(6) We unload by hand, at a cost of 7 cents per ton.

(7) Kind of harvester used: Patented beet pullers and a side-lifting plow. We believe the plow to be the best.

(8) The average yield of beets was 7½ tons per acre.

(9) Value of lands, $40 to $75 per acre; rent, $3 to $7 per acre.

(10) The estimated cost of producing beets was $35 per acre, including rent of land.

(11) Our labor is mostly American, some German, Polack, and Assyrian. Wages are from $1 to $1.50 per day. The supply of labor is good.

(12) We use foreign-grown German seed, mostly Kleinwanzlebener, costing 15 cents per pound. We use 15 pounds to the acre.

(13) Beets are hoed not more than once, cultivated 4 to 6 times, and irrigated when the Lord pleases.

(14) Freight charges on beets: For a haul of 25 miles or less, 40 cents per ton; for 25 to 45 miles, 50 cents; 45 to 60 miles, 60 cents; for 60 to 80 miles, 70 cents.

(15) Number of contract farmers, 900.

(16) We do not attempt to produce our own sugar-beet seed.

(17) Pulp for feeding is free to our contracting farmers; the balance we sell at 10 cents per ton. It is growing in popularity.

(18) The amount of pulp produced we estimated at 40,000 tons. All that is not hauled away by the farmers is sold to one party.

(19) There is more dairying than stock feeding in this vicinity.

(20) Rotation of crops is not generally practiced here.

(21) All kinds of ground are used, from light sand to muck. The preceding crop varies.

REPORT FROM A THIRD MICHIGAN FACTORY.

(1) The general conditions for the sugar-beet industry in Michigan are good. We had an excellent season in 1898. In 1899 we had too much rain at first, and then at the end of the season extremely dry weather. In 1900 and 1901 we had good seasons, that of 1900 being excellent. The season of 1902 was extremely unfavorable. The whole summer was nothing else than a rainy season, and the greater part of the land was flooded most of the time. The farmers in general seem to be satisfied. The good farmers, who exactly follow our advice in rotating grain, clover, grain, and beets, and who keep the necessary amount of live stock, are obtaining excellent results, and are making money as fast as the farmers in the old beet districts of Germany have done.

(2) The price paid for beets is $4.50 for 12 per cent beets, and 33⅓ cents for each additional per cent. The average price paid during the season of 1901 was $5.55, and for the season of 1902, $5.20 per ton.

(3) The number of acres planted in 1902 was 10,551.

(4) We worked 64,063 tons of beets, automatic scale weight.

(5) In determining tare, the beets are brushed with wire brushes, being weighed and reweighed by a small automatic scale.

(6) We unload all beets with forks, and do not use dumps. It costs us about 8 cents per ton.

(7) We use the simple beet puller. We lift the beets and top them by hand, and no harvesters are used.

(8) Our average yield per acre in 1901 was 9½ tons, and in 1902 6½ tons. The highest yield was 22 tons per acre.

(9) The value of land is from $40 to $100 per acre. Rent is from $4 to $10 per acre.

(10) Cost of producing beets is from $30 to $45 per acre, according to how well the land has been farmed during previous years, whether or not it is full of weeds, whether it is properly drained, and the stock of plant food it contains.

(11) The labor we use is picked up all around the cities and country generally. The last two years we introduced some German labor from Nebraska and other States, which has proven satisfactory to our farmers. They work together in families, and the farmers furnish them houses to live in. The cost of such labor is $20 per acre, and they do all the hand work which the beet crop entails. Other labor, if we engage it by the day, costs from $1 to $1.50.

(12) The kind of seed used around this factory very successfully for the last four years is Hoerning's Improved Kleinwanzlebener Special Elite, imported from the old beet-seed district in the Harz Mountains, Germany. We charge the farmers 15 cents per pound, and recommend them to plant from 15 to 20 pounds per acre.

(13) We recommend hoeing the beets twice after thinning, and three times will be still better, and is the practice of a great many farmers. We cultivate the beets generally once every week or ten days until the leaves cover the ground and we can not get into the field to cultivate.

(14) Freight charges on beets are 40 cents per ton for 25 miles or under; 50 cents for 25 to 40 miles; 60 cents for 40 to 60 miles; 70 cents for 60 to 80 miles; 80 cents for 80 to 100 miles.

(15) The number of contracting farmers in 1900 was 1,461, and in 1902, 2,270.

(16) We produced a small amount of home-grown seed in the last two years, not to exceed 3 tons. It was grown from the seed we imported, and proved to be just about as good.

(17) Pulp feeding meets with success. The number of farmers who take pulp increases each year. They get the pulp free of charge at our factory.

(18) The balance of the pulp which the farmers do not take is washed into a large settling basin where it is drained, and is let lie there.

(19) Stock feeding and dairying have increased a great deal in this vicinity since the factory started.

(20) The most common rotation of crops among the farmers here is beets, grain, corn, and beets again; or grain, corn, clover, and beets. We recommend beets, summer grain with which clover is sown, clover stubble manured and either put in beets or put in winter grain and followed by beets the next year.

(21) The kind of soil in this vicinity is a first-class sugar-beet soil, exactly as in the old beet-sugar districts in Germany around Magdeburg, Halle, and some other places. The farmers are finding out that they are raising excellent grain and clover crops after beets.

REPORT FROM A NEBRASKA FACTORY.

(1) The general conditions during the season of 1902 were rather unfavorable on the whole. During the planting season the conditions were favorable enough, but later the precipitation of moisture was at intervals too heavy. We had 6.24 inches rainfall in June and 7.16 inches in July, and while this was not too much, if properly distributed, yet coming as it did pretty much at one time, it delayed work and made it more expensive to clean fields, with resulting damage to the crop. We had a wet fall, from September 15 well up into December, the precipitation being 3.53 inches in the latter part of September, 2.51 inches in October, 1.48 inches in November, and 1.29 inches in December, not counting snows. The extreme wet condition of the soil not only caused leaf spot to develop and damage the crop, but it made harvesting difficult and expensive on account of bad roads and the muddy condition of the ground. At the same time the moisture kept the crop growing late, prevented natural ripening, and the number of cloudy days seriously affected the storage of sugar by the beets.

(2) We paid a minimum price of $4 per ton for beets testing 14 per cent or less, and 25 cents additional for each per cent of sugar above 14 (fractions in proportion), the factory paying the freight rate, making our beets cost us $4.53 per ton.

(3) The area in beets was 3,700 acres.

(4) The total production of beets was 36,884 tons.

(5) To determine the tare we take a sample of 30 pounds from each wagon, and three samples from different places in each car, which we average. The sample baskets are filled with a fork, just as though they were going to be thrown in the storage bin.

(6) We do not use dumps. Our sheds are arranged to unload with nets, but so far the farmers have not equipped themselves to have their beets unloaded in this way.

(7) We have not used anything in the shape of a harvester. We just plow them out with beet plow and top by hand.

(8) The average yield was 9.97 tons per acre.

(9) The price of land is $65 to $70 per acre; the rent $3 to $5 per acre.

(10) The cost of growing beets is about $35 per acre where all the work is hired, though farmers who have help of their own claim they raise them much cheaper.

(11) We employed day labor. Men cost $1.50 per day, women $1 to $1.25, and boys and girls from 50 cents to $1 per day. Labor was very scarce during the fall.

(12) We used various kinds of seed, mostly Original Kleinwanzlebener, Pioneer Kleinwanzlebener, Dippe Kleinwanzlebener, and Dippe Zehringen.

(13) Beets were all hoed once and some of the fields twice, the last hoeing being to clean out weeds only. They were cultivated four, five, and six times. We have no irrigation.

(14) Our freight rate was 50 cents for distance of 150 miles on a single line of road, and double that for longer distances.

(15) We had 262 contractors.

(16) One of our contractors raised about half a ton of seed, which gave good results, a little better he thought than those obtained from imported seed.

(17) The pulp has been fed to 4,500 steers. We furnished the pulp all to a cattle-feeding company without charge, and they consider it a very valuable food.

(18) We have no way of telling the amount of pulp produced, probably about 19,000 or 20,000 tons. Part has been fed, and the balance is stored in a silo and is being fed now.

(19) There is very little dairying here, though it is now starting up some, and we already have applications for pulp from dairymen for next year.

(20) The land being new out here, rotation of crops is not carefully practiced yet. Some beets are planted on a two-year rotation with corn. Some adopt a three-year rotation, corn followed by oats or wheat and then beets.

(21) We have a variety of soils—clay loam, sandy loam, and heavy gumbo—all giving good results. Beets here are planted after corn, wheat, or oats.

REPORT FROM A UTAH FACTORY.

(1) The weather early in the season was favorable for rapid growth and had much to do with the good stand that was generally secured. The fall weather was dry and sunny, favoring the harvesting and preserving the beets from great deterioration. The rapid growth during the spring and early summer caused the thinning season to come on quickly, and many growers were not equal to the task; hence the thinning and weeding became rather in arrears. The midsummer weather was hot and dry, so that something like one-third of the crop was not irrigated at all. This occurred after a rather rainy period in the spring, which caused the soil to become harder than usual, and many failed to begin deep cultivation early enough to keep the ground loosened properly.

(2) Price paid for beets, $4.50 per ton at the plant.

(3) Number acres planted, 4,238.

(4) Quantity of beets paid for, 42,472 tons.

(5) Our average tare was 3.02 per cent. We have very little trouble with farmers regarding tare, and in every instance when their loads have been tared by selecting a bushel and weighing in the gross and then cleaning and topping properly and reweighing, they have been content to have the tare estimated as in the usual way. The tare is very moderate, as you will perceive, but we have no "chrono" at the plant to check the weight of beets received and worked.

(6) Beets are unloaded by hand into sheds from wagon and car.

(7) For harvesters there are used common plows with mold board removed, subsoil plows, and regular beet pullers. The latter are better when land is hard.

(8) Average yield from acres harvested, 10.45 tons per acre.

(9) Average value of land with water right and improvements, $100 per acre. Rents average about $10 per acre and run as high as $20.

(10) Reasonable cost of raising an acre of beets based on actual accounts received from reliable growers with good crops, $36 per acre including all but rental of land and water right. Items run as follows: Plowing, $2; preparing, $2.50; planting, $2.75; thinning and hoeing, $5; five cultivations, $2.50; irrigating, $1.50; harvesting 16 tons beets, $19.75. The above does not include fertilizers, and this is not a locality where manuring or any form of fertilizing other than that from the growth of alfalfa is carried on systematically.

(11) The labor is principally local, with some few Japanese who are excellent workers. The cost of common labor on the farm is $1.25 per day; beet thinners get 75 cents and Japanese $1 per day. The supply of cheap labor is becoming scarce and the cost is gradually increasing.

(12) The seed costs 15 cents per pound. It is obtained from Germany, and 17 pounds per acre are used.

(13) One hoeing is usually all that is given. A second is necessary on land that is somewhat foul with weeds; if this is given, the cost per acre as stated above will have to be increased to $40 per acre exclusive of rent and water right. The beets are irrigated twice or three times when thoroughly done, but there are few of our growers who can actually water all their fields so abundantly as this.

(14) Freight charges for the most part run 35 cents per ton, of which the company pays 10 cents and unloads from the car to the sheds, so that most of the beets net the grower $4.25 per ton on cars.

(15) There were 967 growers in 1902.

(16) No seed is grown at this plant.

(17) Pulp is very popular as feed, some paying as high as 90 cents per ton from the silo, but this season (1903) the pulp will be sold by the company and the growers can secure approximately one-half the beet tonnage they deliver in pulp at 50 cents per ton, while the remainder will be sold to feeders at best prices possible.

(18) We calculate that the pulp from silo will, after fermentation and the drainage that occurs, amount to about one-half the weight of the beets cut. Most of it is used from the silo, hence this weight is not far from correct.

(19) Stock feeding is carried on at the plant by a number of stockmen; and, likewise, the sheep growers are wintering largely in the vicinity and feeding pulp heavily. Dairying is increasing, and while the individual dairymen have but small dairies, yet they use pulp where located within reasonable hauling distance, and creameries are being added constantly at various points in the vicinity of the sugar plant. There is no trouble in disposing of the pulp.

(20) Rotation of crops is not carried on as efficiently as it should be, for the farming had been very slack here previous to the establishment of the sugar and canning plants; and, while there were a number of small farmers in the country, they were merely existing by raising a part of what they consumed and acting as laborers to secure a little ready money; and taxes were the extreme hardship of their lives. Small farms in the East would not have paid for the burial of the owners, to say nothing of furnishing a living if worked as the majority of such farms here were worked previous to the introduction of the sugar industry. There is much improvement needed yet by the small farmer before the full measure of his success is reached. This is a most favorable locality for markets, and when the farmers become so interested as to carry on rotation of crops and fertilize and irrigate intelligently, and when they realize the value of early and deep cultivation to protect against drought, they will reach a degree of prosperity that will be wholesome to say the least.

(21) The soil varies from light sand to sandy loam with small tracts of gravel near the mountains, and heavier soil, containing considerable alkali, on the level between the mountains and the Great Salt Lake. There are benches of higher lands running from the base of the mountains toward the lake flats, and these furnish the better grades of soil for the beet growing and will subirrigate in a satisfactory manner. In the Government investigations this soil has been classed with the Fresno sand and the Fresno sandy loam. There is more attempt to grow beets after alfalfa than at first; but other than this there is little done toward systematic rotation of crops; but beets can be grown profitably on this land by manuring lightly each season, or heavier each alternate season, as the land is provided with the mineral salts in abundance, and, when these become properly disintegrated and a supply of nitrogen is furnished, there is a constancy about its productiveness that is pleasing.

REPORT FROM A SECOND UTAH FACTORY.

(1) The season was rather late in opening, but after the weather became settled it was favorable to rapid growth and to a good stand, an excellent stand being generally secured. Late planting and rapid growing weather prevented proper thinning.

(2) The price paid for beets was $4.50 per ton at the plant, the minimum for quality being 14 per cent of sugar and a purity coefficient of 80.

(3) The number of acres planted was 5,498; the number harvested, 4,672.

(4) The gross weight of beets received was 38,129 tons; the net weight, or the amount paid for, was 36,942 tons.

(5) The tare was 1,187 tons, being 3⅕ per cent of the net weight. Tare is estimated generally, but tests are made by sampling and weighing, then cleaning with brush, topping properly, and reweighing.

(6) We have an arrangement for dumping beets from the cars into the silo, but no account of cost was kept. Wagons are dumped or unloaded by hand.

(7) Beets are harvested by means of common plows and beet pullers. The latter work satisfactorily.

(8) The average yield of beets was 7.9 tons per acre.

(9) Land values are about $75 per acre, and rents approximately $7.50 per acre.

(10) The cost of raising beets is about $36 per acre, exclusive of rent for land and water and without fertilizer. The costs of operations in detail per acre are about as follows: Plowing land, $2; getting land ready for planting, $2.50; planting, $2.75; thinning and hoeing, $5; cultivating five times, $2.50; irrigating, $1.50; harvesting (with yield of 16 tons per acre), $19.75.

(11) Labor is mostly local, and costs from 75 cents to $1.25 per day for farm work. Very little outside labor is employed. Some effort has been made to get Indians to work in the beet fields, but no reports of results are available at present.

(12) The seed used is from Germany, and costs the growers 15 cents per pound. About 15 pounds per acre are used.

(13) The beets are usually hoed once when thinning, and very little hoeing is done thereafter. The best farmers cultivate five times, but in many cases two cultivations are all the beets get. They are irrigated two or three times when water can be secured.

(14) Freight charges are 35 cents per ton, and this expense is borne entirely by the growers.

(15) We had 1,093 contractors in 1902.

(16) No seed is grown by this company or by anyone else for use in this section.

(17), (18), and (19) Pulp is coming into favor as a stock food for cattle and sheep. There is little dairying here. The pulp has been sold to a feeding company, but next year (1903) it will be sold to the beet growers at 50 cents per ton to the extent of one-half the weight of beets they deliver, the pulp to be removed not later than March 31 of the following season. The surplus pulp will be sold to feeders on the best terms possible. The pulp, after being siloed and fermented, amounts to about one-half the weight of the beets.

(20) No particular system of rotation is followed. The main crops are wheat and alfalfa. Some oats are grown.

(21) The soil is principally clay loam, with occasional ridges of sandy land. The main body of tillable land lies slightly sloping to the center of the valley, and the alkali is found to collect in the lower sections.

The main requirements in regard to the field conditions would seem to be the necessity for some increased supply of cheap labor, and then a scheme of careful superintendence of the growers during the season. Seeding must be done promptly, for the season is later than in other localities; and the thinning must be closely watched, for the inclination has been to leave plants too close together. The value of deep mulch and the use of the cultivator must be constantly dwelt upon, for there is too much dependence placed upon irrigation and a disposition to cease work as soon as dry weather prevails and water is scant in the canals. There is much disappointment met with, also, where the supply of water is abundant and its use is continued without cultivating afterwards, for in this case there is a magnificent growth of leaves, which indicate a splendid condition of the crop, but upon harvesting the roots are small, and the condition is similar to that of grain that runs largely to straw.

REPORT FROM AN OREGON FACTORY.

(1) There was nothing unusual about the early weather, but, as usual, it was rather cold and dry for early growth.

(2) We paid $4.50 per ton for all beets running 12 per cent sugar and having purity of 80 or over, beets to be delivered at the factory. The quality of the beets is high.

(3) The acreage harvested was 2,600 acres. The acreage is increasing.

(4) We worked 17,686 tons of beets.

(5) The tare amounted to 5⅛ per cent of the weight of the beets paid for.

(6) Beets are unloaded by hand from cars and wagons to sheds.

(7) Plows and beet pullers are used in harvesting.

(8) The average yield from acres harvested was 6.8 tons.

(9) Dry land in sections where beets are grown runs about $60 per acre. The rent is about 10 per cent of the value of the land. Such land is only worth one-half as much as irrigated land for beets and less than that for many other purposes.

(10) The cost of producing beets is about $25 per acre for dry land not irrigated or fertilized, and not counting interest on investment.

(11) The labor is mostly local, though in a few instances the growers have brought in foreigners from Europe. But this has not been done to any considerable extent, and the main difficulty as yet is to secure a supply of cheap labor.

(12) The seed used is imported from Germany.

(13) The beets are mostly grown without irrigation. Generally the acreage is so large that but little work is done on the crop after thinning, which is one reason why the acreage cost of production is low. The slack methods of cultivation prevailing in western sections can not be charged up to the sugar-beet industry, inasmuch as wheat growing in its crudest form was the highest cultivation known prior to the introduction of the beet crop. The value of early and deep cultivation is not yet appreciated.

(14) Freight rates are 50 cents per ton and are paid by the grower.

(15) There were 115 growers, averaging 26.1 acres each.

(16) No seed is grown here.

(18) The pulp produced, when drained and fermented, amounts to about 50 per cent of the weight of the beets. The pulp is all sold to one party for a definite sum.

(19) Stock feeding is practiced considerably, but there is very little dairying, there being a scarcity of small, thrifty farmers.

(20) There is very little rotation of crops practiced.

(21) In one part of this section the soil is sand and clay mixed; in the other and higher part it is mostly sandy loam to light sand.

REPORT FROM A MINNESOTA FACTORY.

(2) The average price paid for beets was $4.92 per ton.

(3) Number of acres planted to beets, 3,800.

(4) Number of tons of beets worked, 32,000.

(5) The methods of tare employed by us are those employed by most factories. We draw samples from each wagon or carload from the top, from the center, and from the bottom, fill a basket containing net 50 pounds, subject these beets to a washing and cleaning process, and weigh them again after they have been partly dried, counting about 1 per cent for moisture absorbed.

(7) As to kind of harvesters used, we have supplied to our farmers an improved beet puller, which has given satisfaction.

(8) Average yield of beets per acre, 9.1 tons.

(9) An acre of land suitable for beet crop and convenient to railway station varies in value from $60 to $75 per acre. The rents paid by some of our beet growers are $2.50 to $3 per acre for unplowed land, and $6 to $9 per acre for plowed land.

(10) The cost of producing beets, including hauling and loading in cars, varies from $25 to $30 per acre.

(11) Women and children are employed to a large extent for the hand work in localities which are well populated. On many of the small acreages members of the farmer's family do the entire labor. Compensation for hired help, if given out by contract, is from $18 to $20 per acre, which includes all the hand work—bunching,

thinning, hoeing, pulling, topping, and loading in wagons. Team work—plowing, sowing, cultivating, and plowing out by beet puller—is $2.50 to $3 per day.

(12) In regard to seed, we supply to our beet growers uniform quality of Kleinwanzlebener variety imported direct from producer.

(14) Freight rates on beets range from 50 to 85 cents per ton.

(15) The number of contracting farmers in 1902 was about 2,000.

(16) We never have produced or supplied home-grown seed. Our experiments in that direction have proved a failure. The efforts in that direction should, in our opinion, be put under supervision of officers of the United States Department of Agriculture.

(20) Most of our beet growers have now adopted the method of diversified farming, rotating their crops of small grain, corn, clover, potatoes, etc., with that of beets every two years.

(21) All our beets are produced on a sandy-loam or black-loam soil with a clay subsoil.

REPORT FROM ANOTHER FACTORY.

(1) The season was very unfavorale. There were almost continuous rains during planting and thinning time; also during harvesting.

(2) For beets we paid the farmers an average price of $5.07 per ton.

(3) The number of acres planted to beets was 8,000.

(4) The number of pounds of beets worked, 43,485,600.

(5) The washing process is employed in estimating tare.

(6) Beets are unloaded by hand.

(8) Six tons per acre was about the average yield on acreage harvested.

(9) Land is worth $25 to $40 per acre. Rents range from $2 to $6 per acre.

(10) It costs from $25 to $40 per acre to grow beets.

(11) We depend on local help and extra labor brought from cities. The supply is fair, but the quality is poor. The wages are 15 cents per hour.

(12) We use only foreign-grown seed, which costs the farmers 15 cents per pound. The amount used is 15 pounds per acre.

(13) The beets are hoed not to exceed twice. They are cultivated three to five times, and are irrigated profusely.

(14) Freight rates, under 25 miles, 40 cents per ton; 25 to 40 miles, 50 cents.

(15) The number of contracting farmers was 1,283.

(16) We produce no sugar-beet seed.

(17) The pulp is given to farmers. Very little was used during the past season.

(19) This is a good stock country. There is a cheese factory in this village, and a creamery in an adjoining town. It is a great hay, oats, and stock country.

(20) The land is level, mostly clay loam. The prevailing crops are hay and oats.

CONTRIBUTIONS FROM THE BUREAU OF PLANT INDUSTRY.

PREPARED UNDER THE DIRECTION OF B. T. GALLOWAY, CHIEF.

LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
Washington, D. C., May 6, 1903.

SIR: I submit herewith, for publication as part of the Report on Progress of the Beet-Sugar Industry for 1902, the following papers: (1) "Single-germ beet balls and other suggestions for improving sugar-beet culture," by Truman G. Palmer, and (2) "Sugar-beet seed: Its importance and production," by J. E. W. Tracy, of this Bureau.

Respectfully,

B. T. GALLOWAY, *Chief.*

Hon. JAMES WILSON,
Secretary of Agriculture.

SINGLE-GERM BEET BALLS AND OTHER SUGGESTIONS FOR IMPROVING SUGAR-BEET CULTURE.

By TRUMAN G. PALMER.

The suggestions made in the accompanying pages for improving some of the methods connected with sugar-beet culture in this country are based on personal observations extending over a number of years. In February last I had the honor to suggest to the officials of the Department of Agriculture the idea of producing single-germ beet balls as one means of materially reducing the necessary quantity of seed, eliminating the labor of thinning and bunching beets, and thereby lowering the cost of producing sugar from beet roots.

While the matter here presented is only suggestive, it is hoped that it may be of value to experimenters and others who are engaged in building up and encouraging an important industry.

TONNAGE AND PRICES OF SUGAR BEETS.

Before treating the subject of increasing the tonnage of sugar beets specifically, an observation as to what is possible of accomplishment from the farmer's standpoint may not be inopportune, although in doing so ground must necessarily be covered which is well known to those who are familiar with the industry.

By experience it has been found that large beets are liable to be low in sugar content, while small beets do not yield sufficient tonnage.

A 2-pound beet gives the best average results. Planting in rows 18 inches apart and thinning to 8 inches gives 43,243 beets to the acre; and if each beet grew to weigh 2 pounds, the yield would be 43¼ tons per acre. This, then, is the maximum yield of ideal-sized beets for factory purposes.

The average yield in Germany is 12 to 13 tons, in Austria 8.5 to 10 tons, in France 10.75 to 12 tons, in Russia 4.7 to 6.5 tons, while in the United States in 1901 it was 9.6 tons, and in 1902, it was 8.4 tons, both of which figures are undoubtedly below the normal average, as both seasons were unfavorable to beet culture in most sections. Fifteen to 18 tons per acre is not an uncommon yield in some localities in this country.

The price of beets in the United States runs from $3.50 per ton for a 12 per cent beet up to considerably more than $5 for the high-grade beets of some sections.

In portions of Nebraska, for instance, where the beets are rather low in both sugar and purity, the price is necessarily below the average, or the factories would be unable to slice them at a profit.

Nature however, recompenses the Nebraska grower, for he is not put to the expense of irrigating as is the case farther west; nor is he compelled to cultivate as extensively as are the beet raisers in some of the more humid States. The factories also recompense the growers by giving them the pulp, which is worth $1.50 per ton for feeding purposes.

Owing to the high sugar content and purity, the price of beets in the mountain States and in portions of some other States, is often in excess of $5 per ton; but fair conclusions can only be arrived at by using the average tonnage and the average price per ton as a basis.

In 1901, the average price throughout the United States was $4.50 per ton. In 1902, the farmers produced a better grade of beets, some of the factories increased the price per ton, and the average was brought up to about $5.

With the low average yield of 9.6 tons at $5 per ton our farmers receive $48 per acre, gross, or a net profit of $18 per acre if we accept $30 per acre as the average cost of production.[a] As compared to the gross average returns from the culture of our leading cereals, the following figures[b] are suggestive:

	Average yield per acre.	Average price per bushel.	Gross returns per acre.
	Bushels.		
Corn	16.7	$0.605	$10.10
Wheat	15	.624	9.36
Barley	25.6	.452	11.57
Oats	25.8	.399	10.29

[a] U. S. Department of Agriculture; Report on the Progress of the Beet-Sugar Industry, 1901, p. 11.

[b] U. S. Department of Agriculture; Yearbook, 1901, pp. 698–705.

If the necessary labor can be greatly reduced and the tonnage doubled or trebled, the agricultural returns in producing at home the raw sugar, for which in 1901 the United States proper sent abroad more than $122,000,000 and for which our people paid the refineries over $159,000,000, will be almost beyond estimation.

In America our inventive genius has largely eliminated hand work in both field and factory, and the most serious obstacle to sugar-beet culture is the hand work of thinning the beets after they are planted and of topping them when they are plowed out.

PULLING AND TOPPING MACHINES.

The work of perfecting a successful pulling and topping machine to do away with hand work and at the same time save $5 to $8 per acre in labor has reached the point where several inventors claim to be absolutely successful. In any event, they have so closely approximated it that perfect success can be confidently expected within a very few years. This will leave only the thinning to be done by hand, and it is to the elimination of this remaining hand work that I desire to direct particular attention.

While a perfect-working pulling and topping machine will save much hand labor and will perhaps slightly increase the tonnage by more perfectly topping the beets than can be done by hand, to remove the necessity for thinning would not only save a like amount in labor but would result in greatly increasing if not doubling the tonnage.

MULTIPLE-GERM AND SINGLE-GERM BEET BALLS.

The prophecy was recently made by the Secretary of Agriculture that sugar would eventually be produced from American-grown sugar beets at a cost of 2 cents per pound. Such a result is only possible by largely eliminating the hand work in the field and by removing one of the main causes of low tonnage, namely, the injury inflicted on the remaining roots by the removal of the superfluous ones.

For several years I have realized that if a beet ball could be bred to produce but one plant the difficulties mentioned would be removed; but no one to whom it was mentioned would admit that science could so radically change the character of plant seed. When the attention of the officials of the Department of Agriculture was called to the subject, they gave it immediate consideration and reached the following conclusions:

(1) That the Department of Agriculture has overcome far more serious obstacles than those which seem to be involved in the production of single-germ beet balls.

(2) That the desired result would be of great value to the beet-sugar industry.

(3) That a series of experiments looking to the desired end should be inaugurated at once.

Investigations and experiments have already been started by the Department of Agriculture, and it is hoped that the State experiment stations may be led to undertake similar lines of investigation. The first questions involved have to do with the selection of single-germ seed already in existence and then the planting and growing of these seeds to get this characteristic fixed. After this is accomplished, of course it will be necessary to follow all of the intricacies of sugar content, size, etc. All of this will take time, and it will undoubtedly require several years before practical results can be attained.

MULTIPLE-GERM BEET BALLS RESPONSIBLE FOR HAND THINNING.

No other work has such an influence on the tonnage as that of thinning. It is the most expensive and laborious work attached to the culture of sugar beets, and to attain the best results it must be most carefully done at the right time.

This careful labor is necessitated by the peculiar character of the beet seed, which, unlike an ordinary single-germ seed, is really a combination of from one to six seeds, each entirely separate and disconnected from the others, but all encased in what is called a "beet ball," an irregular-shaped structure of brittle woody matter about as large as a French pea.

The seeds themselves form but a mere fraction of the ball, the great abundance of woody matter surrounding them being provided by nature to aid the germs themselves in various ways. Soaked in water the porous beet ball will absorb 65 per cent of its weight in moisture in twenty-four hours, and when planted in damp ground rapidly draws the moisture to it.

In planting beet seed the beet balls are thickly drilled in rows, the latter usually being 18 inches apart, and the seeds germinate in two to four weeks, depending upon the condition of the soil and weather, while the weed seeds which are only incased in thin shells are up far in advance of the beets.

When the seedlings are up and have gained sufficient size to show the third leaf they should be thinned. The thinning can not well be done before this time, and if put off until they are larger the pulling up of the superfluous sprouts injures the roots of those which remain, and the result is a low tonnage. The work is done by people on their hands and knees, who pull up the weeds and all of the beets except the most thrifty one to be found about every 8 inches. Most of the beet balls send up several sprouts, each of which would make a beet if allowed to grow, and as the beets can not be grown to advantage in clusters, to secure the best results the separation of the tender shoots must be thorough and should be carefully done at the right time, so as not to injure or disturb the roots of the remaining plant. It was this laborious, careful work that led me to suggest the advisability of securing by selection or by breeding a single-germ beet ball which may be drilled a single ball in a place at any desired distance, and as

each ball would produce but one seedling or beet the superfluous seedlings could be cut off with a three-cornered hoe instead of being pulled up, thus incurring no danger of disturbing the roots of those left to make the crop.

ADVANTAGES OF SINGLE-GERM BEET BALLS.

Some of the agricultural advantages to be gained by securing a single-germ beet ball are as follows:

(1) As with reasonable care the removal of the superfluous beets could not damage any of the roots which are to remain in the ground, a saving of $1 to $2 an acre in seed could be effected.

(2) To-day the farmer's sugar-beet acreage is limited to such an area as he can reasonably expect to secure the necessary labor to thin within a given period after the plants shall show the third leaf. Inasmuch as, with a single-germ beet ball the little thinning necessary could be done with a hoe and need not interfere with the remaining roots, and as this work could be extended over a longer period of time, the farmer could greatly extend his beet plantings with the same amount of available labor.

(3) As none of the roots of the remaining beets would be injured by careless thinning or not thinning at the proper time, the tonnage per acre would be greatly increased.

OBJECTIONS TO SINGLE-GERM BEET BALLS.

After presenting the matter to the Department of Agriculture I laid it before the agricultural experts of each American beet-sugar factory inviting such criticism as might occur to them. Generally speaking, these gentlemen immediately realized the important bearing which such a development would have on the industry. The few objections presented came from territory west of the Missouri River and were as follows:

(1) Owing to the fact that it takes several weeks for a beet seed to germinate and that in the meantime there may be showers or storms, as the result of which the soil may become crusted, fear was expressed that the single beet plants might be unable to break through this crust, whereas clusters of shoots from multiple-germ balls as at present planted do succeed in breaking through.

(2) The second objection urged was that inasmuch as weed seeds start much earlier than those of the beets, so that the weeds are well advanced when the latter come up, oftentimes surrounding and smothering the beets, there would be much less likelihood of securing a good stand where but one seed was planted in a place than where the seeds are thickly drilled in.

As a beet ball will absorb 65 per cent of its weight in moisture within twenty-four hours, and as it must be thoroughly dampened before it will germinate, I can see no good reason why a great por-

tion of this work should not be done prior to planting, instead of waiting for the ball to absorb its full quota of moisture from the soil.

If the germination can be hastened so that the seedlings are up a few days instead of several weeks after planting, the liability of their being unable to get through a soil crusted by showers will be greatly diminished, as, the period between planting and germination being shortened, the danger from showers will be correspondingly reduced.

As regards weeds, the writer is aware of the fact that a sugar-beet field should be free from weed seed before it is planted to beets, but such is rarely the case; and why a farmer should be compelled to plant a dry, woody beet ball, well knowing that before it germinates the soil will be covered with weeds is hard to understand, providing a practical method of soaking the seed before planting can be secured.

The German method of soaking the seed in animal urine not only hastens the germination but imparts additional fertilizing properties to the beet ball, thus producing a more thrifty plant, although sometimes killing some of the weaker ones.

Agricultural science will yet point out a definite method which will not only hasten the germination but benefit the seed without risk of injury.

(3) Another objection offered was that on new Western soil cut worms, beet flies, and other insects are likely to appear when the beet is young, and that, unless a sufficient quantity of seed is drilled in to feed them and still leave enough beets for a stand, they may take all of the beets.

This objection was made to planting a seed every 8 inches. If the seeds were drilled in every 1, 2, 3, or 4 inches there probably would be enough to answer all purposes, and when they had served their purpose the superfluous plants could be removed with a hoe. The increased tonnage resulting from the hoeing would far more than pay for its cost.

(4) Still another objection urged was that it would be difficult to feed wet seed through a drill.

This objection could be easily overcome by allowing the surplus or surface moisture on the beet ball to dry off, when the beet balls, owing to their increased weight, would run through a drill more easily than does the dry seed.

Owing to the saving in labor and to the other advantages to be gained by planting single-germ beet balls, I am firmly convinced that the securing of such a seed will revolutionize the agricultural end of the beet-sugar business and enable our farmers to produce sugar beets at a greatly reduced cost.

THE INFLUENCE OF EARLY THINNING.

The influence of early thinning with the present multiple-germ beet ball is of the greatest importance, and late thinning is largely

accountable for the present low tonnage of beets as compared with a maximum crop of 43¼ tons per acre.

This influence has been thoroughly demonstrated in Germany by the following and other exhaustive experiments most carefully conducted by the best agricultural experts.

The report of these investigations says that four adjoining acres were similarly prepared, planted the same day, and, aside from the time of thinning, all received identical treatment.

The first acre, thinned at the right time, yielded 15 tons.

The second acre, thinned one week later, yielded 13½ tons.

The third acre, thinned two weeks after the first, yielded 10 tons.

The fourth acre, thinned three weeks after the first, yielded 7 tons.

Estimating the value of the beets at $5 per ton, it will be seen that by thinning at the proper time the returns were $75 per acre. One week's delay meant a loss of $7.50 per acre; two weeks' delay caused a loss of $25 per acre; while three weeks' delay resulted in a loss of $40 per acre, bringing the returns down to $35 per acre.

Any further illustrations as to what it means to the farmer to properly thin his beets at the opportune time would seem to be superfluous.

MACHINES FOR PLANTING BEET BALLS.

As described to the writer, one of the machines which has recently been invented for planting beet balls singly is as follows:

A continuous narrow strip of very thin tissue paper tightly rolled up is placed on a spindle. From this spindle the paper is rerolled on another spindle, the paper in the rewinding process being twisted into a cord or small rope. The machine is set so that as the paper leaves the first spindle and the twisting process begins, beet balls are automatically fed into the curved paper at such intervals as may be desired.

When the spindle is filled with the twisted paper containing the beet balls, it is transferred to an agricultural implement which is pulled across the field by horses. As the implement progresses, it makes a trench into which it unrolls the paper rope, covers it with earth, and packs it, thus planting a single beet ball in a place.

Perhaps the inventor did not stop to consider that, with the present multiple-germ beet balls the beets would still come up in bunches, and that consequently his process would not eliminate the necessity for thinning, but this would be a practical method of planting the single-germ balls.

I am informed that a dropping drill has recently been perfected which the operator can set so as to drop a single beet ball in a place at any desired distance. This would be a still more simple and less expensive method of planting single-germ balls, but, as with the paper-strip method, would fail to eliminate the necessity for thinning when planting the present multiple-germ ball.

If there were single-germ beet balls to-day, doubtless within one year there would be a dozen machines on the market any one of which would plant them perfectly.

CRACKING THE BEET BALLS AND SEPARATING THE SEEDS.

The results to be obtained by breeding a single-germ beet ball can be anticipated to some extent by any grower, inasmuch as it is found that a slight cracking of the beet ball suffices to separate the seeds from the woody matter which incases them. Generally speaking, the larger the beet ball the more seeds it contains, though this is not always the case. A grinder or cracker set so as to just sufficiently crack the ordinary four-germ ball would miss a large number of two-germ balls, while if set for the average-sized two-germ ball it would injure many of the germs of a four-germ ball; hence it would be wise to first sift the balls into several lots of different sizes, resetting the grinder for each lot, when little or no injury need result from the crushing.

If these cracked balls were not too closely drilled in, they probably could be thinned with a hoe, but in any event the injury done the remaining roots by any process of thinning would not be as great as where several sprouts come up from a single ball. I believe this method is worthy of careful investigation.

As regards cracking the balls into several pieces, but not separating the seeds from the pieces of ball or husk, one of the American field experts writes me that he has seen "a 4-acre field planted in this same way, the farmer running the seeds through a coffee mill and cracking them, and by planting thus, the seed was well distributed along the row and very few beets came up in bunches. The crop proved a success, and the labor was limited."

CULTIVATION.

There are two other primary causes of low tonnage where natural conditions are favorable: (1) The lack of deep plowing, proper fertilization, and other preparation of the soil, including the elimination of weed seed, all of which can be easily remedied by the most obtuse farmer who is willing to expend a dollar if thereby he can secure $2 in return; (2) lack of thorough cultivation, which is necessary, not only in order to keep down the weeds but to conserve the moisture and aerate the soil.

As to the effect of weeds, certainly every farmer ought to know that every weed that grows takes both moisture and nutriment from the soil, and to that extent injures any near-by vegetable growth. In sugar-beet culture, however, where the farmer is striving for quality as well as quantity, the weeds work a double injury; first, by robbing

the plants of nourishment, and, secondly, by cutting down the sugar content through shading.

Not only do frequent hoeings or cultivations keep the weeds down but stirring the soil permits the air to permeate it, and therein lies one of the great causes affecting the tonnage. As illustrative of what proper cultivation means, an experiment which was recently conducted in Germany may be cited. Five adjoining acres were similarly prepared and planted to beets the same day. The treatment thereafter given to the beets was identical, with the exception of hoeing. As the average price of beets in the United States is about $5 per ton, the last three columns in the following table have been added to show what each of these extra hoeings means to the farmer in dollars and cents for every acre so treated:

Number of hoeings, yield of beets per acre, gains from hoeing.

Acre.	Number of hoeings.	Yield per acre.	Value at $5 per ton.	Extra return by additional hoeings.	Extra return per hoeing.
		Tons.			
First	1	7	$35.00		
Second	2	$9\frac{1}{2}$	47.50	$12.50	$12.50
Third	3	$10\frac{1}{2}$	52.50	17.50	8.75
Fourth	4	$12\frac{7}{10}$	63.50	28.50	9.50
Fifth	5	15	75.00	40.00	10.00

In Europe, where labor is cheap and horses are dear, there is not the same incentive to devise implements whereby the work can be done by horses as in the United States where labor is dear and horses are cheap.

The above experiments refer to ordinary hand hoeing, but with our improved cultivators hand hoeing is not so necessary in this country. Even if it were, it is hard to conceive of an intelligent farmer neglecting his beet fields once he is aware of the immense profit to him through giving his sugar beets proper attention.

EFFECTS OF SUGAR-BEET CULTURE.

The influence of beet culture on the farmer's land should also be considered.

This can be done in no better way than by reproducing that portion of the report of one of our consuls to Germany, which treats of the effect of beet culture in rotation with other crops.

The Germans are not only exceedingly systematic, but very scientific, and the following report of exhaustive experiments most carefully made should serve to disillusionize many who still believe that sugar beets rapidly exhaust the soil. The report is as follows:

A German farm of 625 acres produced, before the introduction of beet culture, yearly 9,736 bushels of grain in ten years' average. After beet culture was intro-

duced, with 125 acres yearly to beets, the average yearly grain crop from the remaining 500 acres was 9,870 bushels, or 134 bushels increase. Another farm in the province of Saxony, also of 625 acres, produced before beet culture was introduced, in ten years' average, 13,879 bushels of grain. When five years afterwards 135 acres were planted with beets the grain crop of the remaining 490 acres was 14,365 bushels average, and afterwards, when yearly 220 acres of beets were planted, the average grain crop from the remaining 405 acres was 14,397 bushels, or 518 bushels more than from the whole 625 acres before beets were raised. Thirty-five other farms of 500 to 1,000 acres each in the province of Saxony showed the following results:

Average crops per acre, in pounds.

Crop.	Before beet culture.	After beet culture.	Increase in pounds.	Per cent increase.
Wheat	1,848	2,292	444	24
Rye	1,456	1,672	216	14.8
Barley	1,672	2,094	422	25.2
Oats	1,355	1,918	563	41.5
Peas	985	1,834	849	86
Potatoes	6,716	13,500	6,874	102.3

The average beet crop of these farms was 17⅕ tons per acre.

The above demonstration shows that the farmer who rotates his beets with other crops does not decrease the productiveness of his land when sown to other crops but, on the contrary, greatly increases its productiveness. The truth is that a good farmer can not measure his profits by his beet crop alone, but must consider the extra profit which beet culture enables him to make on everything else he grows.

As a matter of fact, the experience in Germany, where every available acre was under cultivation long prior to the introduction of beet culture, would indicate that the money received by the farmers for sugar beets is largely profit, inasmuch as since the introduction of beets these districts, as a whole, continue to yield a greater tonnage of other crops as well as of meat products.

To substantiate this remarkable result I reproduce the following from the report of Mr. M. S. Brewer, American consul-general to Berlin, given under date of November 12, 1881 (see page 479 of Beet Sugar Industry and Flax Cultivation in Foreign Countries, State Department, 1891):

Concerning the beet-sugar industry, a few explanatory remarks may not be out of place. How much the influence is appreciated of the cultivation of sugar beets upon agriculture and national welfare may be seen from a passage extracted from a very valuable treatise by Richard von Kaumann on sugar industry:

It is an established fact that notwithstanding the extensive cultivation of sugar beets, no decrease in the yield of cereals has taken place, but it has, on the contrary, augmented by double and treble the amount in the districts where sugar beets are planted, and that at those very places the production of meat is steadily increasing. The growth of sugar beets requires that the soil be tilled to a greater depth, thus adding to the thrift also of other plants to be cultivated later on the same soil. Besides, the remnants or waste left in the manufacture of beet sugar furnish not only

an excellent food for cattle, but also a fertilizing stuff, dispensing to a considerable extent with the use of artificial manure. But the profit is also considerable which this industry affords people who work in the sugar manufactories, as they get employment throughout the whole year, during the spring and summer seasons, in the growing and cultivation of the beets, and during the fall and winter in the manufactories.

LOWERING THE COST OF SUGAR.

The question is, How can the farmer be benefited and how can sugar be produced from beets in America for less money than the present cost?

It has been stated that the time would come when the American beet-sugar factories would produce sugar at a profit at 2 cents per pound. While this is an eventual possibility, it should be patent to all that such a revolution in cost of production, if brought about, must come largely from the agricultural end of the industry.

To-day the factories pay $5 for a ton of beets from which they are able to extract an average of 219 pounds of sugar,[a] the sugar in the beets thus costing them $2.29 per 100 pounds.

The average cost of working the beets through the factory is $3.18⅗ ter ton,[b] or $1.45 per 100 pounds of sugar extracted.

The cost of bags or barrels is 10 cents per 100 pounds, while freight, commissions, and other expenses bring the present average cost of producing sugar up to $4 per 100 pounds.

When the American farmer becomes educated to the fact, as recently demonstrated by the Colorado Experiment Station, that beet pulp as compared to other stock foods is worth $1.50 per ton, instead of the sugar manufacturer being obliged to throw his pulp away, the farmer will purchase it at a price based on its actual value, the factory proprietor virtually receiving a rebate of 75 cents per ton on the beets he purchases, inasmuch as 2 tons of beets yield 1 ton of pulp. This will mean a reduction of 34 cents per 100 pounds in the cost of the sugar to the factory proprietors, based on the present extraction of 219 pounds of sugar per ton of beets.

The utilization of pulp and other by-products will probably make a total saving in this direction of one-half cent per pound. The 1899 average "factory expense" of $3.18⅗ per ton of beets can perhaps be eventually reduced to an average of $2 per ton, which would make a further reduction of 54 cents per 100 pounds of sugar, resulting in a saving on these two items of $1.04 per 100 pounds.

The above estimate is based on an extraction of 219 pounds of sugar per ton of beets. When the quality of our beets and the efficiency of our factories are increased, as will be the case, and thus the average

[a] U. S. Department of Agriculture; Report on the Progress of the Beet-Sugar Industry, 1901, p. 36.

[b] Report of Twelfth Census, pp. 543–555.

extraction is increased to 12 per cent, or 240 pounds of sugar per ton of beets, the extra 21 pounds of sugar at the present cost of 4 cents will mean a further reduction in cost of 84 cents.

If, from the present average cost of production of $4 per 100 pounds, these three items are taken—50 cents by utilization of by-products, 54 cents saving in factory expense, and 84 cents in extra sugar—the cost will be brought down to $2.12 per 100 pounds. But as the price of sugar goes down, the 84 cents for extra extraction should also be cut down. Cutting this in half would leave the cost of producing sugar at $2.54 per 100 pounds with beets at present cost and all of the above economies carried out; hence, even then, sugar can not be produced for 2 cents per pound.

The success of the industry depends upon the fairness of both farmers and factory proprietors. The price of beets must be so adjusted as to afford each a fair profit, for neither can be expected to work for the sole benefit of the other.

The present New York wholesale price of granulated sugar is $4.65 per 100 pounds, and the price of the product necessarily sets a limit to the price which the factories can pay for beets.

Looking to a lower cost of production the fact must be recognized that the possible factory economies are limited, while the possible field economies and improvements are great.

Gradually reducing the difference between the present average yield per acre and the ideal maximum yield of 43¼ tons, the utilization of the by-products, and the elimination of hand labor in the field are the things which must solve the remaining problems of the industry.

SUGAR-BEET SEED: ITS IMPORTANCE AND PRODUCTION.

By J. E. W. Tracy,

Seed and Plant Introduction and Distribution, Bureau of Plant Industry.

The beet-sugar industry in the United States has made wonderful headway during the last year and promises to continue to greatly increase in importance in the future. There are now 42 beet-sugar factories in the United States, and three rasping stations which manufacture no sugar but extract the juice from the beets and pipe it to a central station for manufacture. Twelve factories are now being built for this year's campaign. The total capacity of these factories and rasping stations is nearly 40,000 tons of beets daily, which requires the planting of from 350,000 to 400,000 acres of sugar beets. The seed required for this purpose aggregates over 5,000,000 pounds, of which less than 200,000 pounds is produced in the United States. The great bulk is imported from Germany, while smaller quantities come from France, Russia, and Austria. The price paid for this seed varies from 7½ to 17 cents per pound, the average being about 9 cents delivered in Chicago or Omaha.

It costs in the neighborhood of 4¼ cents to grow a pound of sugar-beet seed in France or Germany, but chiefly because of the greater cost of labor in the United States domestic seed can not be produced as cheaply as foreign seed. California and Washington growers receive 10 cents per pound for their product, exclusive of freight charges.

IMPORTANCE OF FIRST-CLASS SEED.

While the amount of money sent abroad for seed is very large, still it is insignificant in importance compared with the results caused by the use of inferior seed and seed not adapted to the particular locality in which it is to be sown. This has been so clearly brought out by Henry W. Diederich, consul at Bremen, Germany, in Consular Reports No. 242, that I can not do better than quote a portion of his report:

> Sugar is made not in the sugar factories, but out in the fields. Therefore, it is impossible to pay too much attention to the cultivation of beets containing the highest percentage of sugar, and, at the same time, yielding the largest tonnage per acre. In order to produce such, the selection of suitable soil, the climate, the rainfall, and length of season, the fertilizing and planting, the cultivating and harvesting—all are very important factors. But the most important of all is to start out with the best seed obtainable; for good seed, after all, is the foundation of successful sugar industry. If I may express an opinion, based on my personal observation, it is that some of our beet growers should insist more than they have upon getting none but the best of seed, no matter what the price may be. * * * The first-class sugar factories of Europe buy none but the very best seed, grown from high-grade individual "mother" beets, to distribute among the beet growers, thus not only maintaining the standard of their sugar beets as to quality and quantity, but also putting themselves in a position to compete in all the markets of the world. This first-class seed

is sold and delivered by the growers on board cars in the Prussian province of Saxony at from 8 to 10 cents per pound, which is a moderate price, considering the fact that it takes at least four years to get it into the market.

There is also a second-class seed offered for sale in this country at from 5 to 6 cents per pound. This is commonly called the "nachzuchtsamen," being a seed produced not from the mother beets, but from the first-class seed mentioned above. This inferior grade, however, is not used by first-class sugar men in Germany, France, Holland, and Belgium, but most of it goes to Austria, Russia, and the United States. And this is the reason why I deem it my duty to call attention to the importance of getting only the very best seed obtainable. In my opinion, those American growers of sugar beets who buy cheap grades of seed make a great mistake. All kinds of seed have a natural tendency to degenerate. Even the first-class beet seed mentioned above will not bring forth beets that come up to the standard of the original or mother beet, but will show a loss of one-half to 1 per cent of sugar content. Now, the second generation of seed will degenerate more than as much again, and lose from 1 to 2 per cent. This is a small amount, when considered by itself, yet it is sufficient not only to turn the profits of a sugar factory into a loss, but even to drive the concern to the wall.

To illustrate this: Factory A slices 50,000 tons (short) of beets, which would yield about an average of 15.5 per cent sugar in the extraction. After deducting the sugar left in the molasses and in other waste, this would leave about 13 per cent—6,500 tons of pure granulated, marketable sugar, which, at $50 a ton, would net $325,000.

Factory B slices the same amount of beets, grown from second-class seed, which, at a fair average, have about 1.3 per cent less of sugar in the extraction. After this material has also gone through the process of refining, there will be 11.7 per cent—5,850 tons—of marketable sugar, which, at $50 a ton, would net $292,500.

It will be seen at a glance that, while both factories use the same amount of material and have the same expenses for labor, fuel, etc., there is a difference in the gross receipts for manufactured sugar amounting to $32,500.

Factory A bought 55 tons of first-class seed, at $180 per ton, $9,900; Factory B bought 55 tons of second-class seed, at $120 per ton, $6,600. It will be seen that Factory B wanted to buy "cheap" and to make money fast. It did, indeed, save $3,300 at the start; but Factory A began by planting the very best seed obtainable, and came out at the end of the season with $29,200 cash ahead of its competitor, and was in the position of declaring a handsome dividend.

Like so many other things in life, the cheapest beet seed is the dearest. It pays to get the very best, and only the very best is good enough. Let the good work of experimenting in the field of sugar-beet culture continue, in order to learn exactly what we can do in the face of fierce and growing competition; but let American growers determine not only to try different varieties of seed, but also to plant none but seed of high grade and pure pedigree.

It is evident that, if the profitable operation of a sugar factory may depend upon a difference of 1 per cent in the sugar content of the beets, it is of the utmost importance that the seed used should be the best obtainable, and that it should also be adapted to the soil and climatic conditions obtaining in the sugar belt of the United States.

All sugar-beet seed grown in France and Germany is grown under practically the same climatic conditions. This seed is received in America and sown in New York and Michigan, Colorado and Utah, California and Washington, States varying widely in climatic conditions. Yet there is probably no other crop where the profitable invest-

ment of millions of dollars is so directly dependent upon the quality of the seed used as the sugar beet.

The beet-sugar industry is now so well established in the United States that it would be poor policy to depend longer on imported seed, there being always a possibility that by failure of the crop, or for reasons political or owing to trade disturbances, the supply of seed may be cut off. Even if this possibility is regarded as remote, it is nevertheless true that American beet-sugar factories will never attain their maximum profit until there is beet seed especially produced to meet American conditions of soil and climate. Seed is now being grown by private enterprise on a commercial scale in Colorado, Utah, California, and Washington, and on a smaller scale in Nebraska, both at Lincoln and Grand Island. The seed produced in California, Colorado, and Utah is mostly used at or near the place of production, while that produced in the State of Washington has been used for two years in California, where, the grower says, it has given such good results that he has received orders for vastly larger quantities than he is able to produce.

The people of Colorado have been so very well satisfied with their success in raising seed that they intend to greatly increase their areas this year, and ultimately to grow the entire quantity of seed used in growing beets for the factories in that State.

IMPORTED AND DOMESTIC SEED.

During the last year experiments to determine the relative values of foreign and American-grown seed have been commenced at different experiment stations throughout the sugar-beet belt, several varieties of the best foreign seed obtainable having been planted in large plots side by side with seed grown in Washington, Utah, California, and Michigan. The sugar content and purity of the beets grown from each sample of seed were determined twice a year from samples of 50 roots or more. The yields were computed by weighing the entire product of each plot at harvest time.

The reports of this work have been most satisfactory, and have shown quite conclusively that seed raised in America is not only good but of excellent quality, and even superior to many of the highest grades of seed purchased abroad. This is especially marked in the case of seed grown in Washington and in Utah.

BREEDING SEED FROM CHEMICALLY ANALYZED ROOTS.

As far as known, with the exception of the work done at Schuyler, Nebr., by the United States Department of Agriculture, where, in 1893, 5,000 tested mother beets were planted, little or nothing had been done in the United States toward raising sugar-beet seed from

chemically selected mothers until a year or two ago, when the Standard Cattle Company, of Ames, Nebr., working in connection with the Nebraska Experiment Station, began raising seed from chemically analyzed roots. They do not, however, base their experiments on seed from individual roots, but group them into classes according to their sugar content—roots having a sugar content of 14 to 18 per cent are put into one class and those having more than 18 per cent into a second class. Five acres of seed from chemically analyzed roots were grown at Grand Island last year, but with rather unsatisfactory results.

The Department of Agriculture has taken up the work of raising seed from analyzed mothers, and is carrying it forward on an extensive scale at the experiment stations in New York, Michigan, Illinois, Colorado, Utah, and Washington. The best procurable seed from Europe has been secured for this purpose. From the beets grown from each sample of seed a large number of roots have been selected and analyzed and set out as mothers for this year's crop of seed. A careful record showing the sugar content, purity, size, shape, conformity to type, and general growing characteristics of each individual root and its progeny is kept. As soon as a sufficient quantity of seed is raised it will be distributed throughout the different sections of the United States for trial by sugar-beet factories and individuals interested in the work.

The Department will endeavor to further encourage the production of sugar-beet seed by aiding the American growers in distributing their seed as far as possible to bring it to the attention of those interested in sugar beets, and by assisting in breeding sugar-beet seed of high quality from individual mothers for the widely separated districts of the United States having different climatic conditions.

American-grown seed is being used almost exclusively by the Department in connection with its Congressional seed distribution this year (1903); and such seed has also been sent in lots of 100 pounds for a commercial trial to a large number of factories throughout the United States.

THE PRINCIPAL INSECT ENEMIES OF THE SUGAR BEET.

By F. H. Chittenden, Division of Entomology.

LETTER OF SUBMITTAL.

U. S. Department of Agriculture,
Division of Entomology,
Washington, D. C., June 6, 1903.

Sir: I submit herewith for publication as a part of the report on the Progress of the Beet-Sugar Industry for 1902 a somewhat extended illustrated discussion of "The principal insect enemies of the sugar beet," prepared by F. H. Chittenden, Entomologist in charge of breeding experiments of this Division.

Respectfully, L. O. Howard, *Entomologist.*

Hon. James Wilson,
Secretary of Agriculture.

INTRODUCTORY.

Although the beet-sugar industry is still in its infancy in America, already many insects—150 species in round numbers[a]—have been found to use beets as food, and, while comparatively few occasion losses of consequence, with the coming of years and the increase of cultivation of the sugar beet, other insects will acquire the habit of feeding upon it, and more extensive injuries may be expected each successive season.

If we leave out such forms of insects as blister beetles, army worms and cutworms, flea-beetles, leaf-beetles, and some few others, we may say that beets at the present time suffer comparatively little damage through insect ravages. The recent extension, however, of sugar-beet culture in this country has been the means of bringing to notice, through the publications of the Department of Agriculture and several of the State experiment stations,[b] a large number of insects not previously identified with attack on that plant.

A very considerable proportion of the insect enemies of sugar beet, which are practically identical with those which affect table beet and

[a] Forbes & Hart, Bul. 60, Univ. Ill. Agl. Expt. Sta., 1900, pp. 397–532.

[b] See Bruner, Bul. 23 [old ser.], Div. Ent., U. S. Dept. Agriculture, 1891, pp. 11–18; Osborn & Gossard, Bul. 15, Iowa Agl. Expt. Sta., 1891, pp. 265–272; also numerous shorter articles.

spinach, subsist normally on wild plants of the same botanical order—the Chenopodiaceæ, or goosefoot family, which includes our common lambsquarters (*Chenopodium album*), spinach, and some related plants that are cultivated for ornament and as forage crops. Of the latter are several forms of saltbush (Atriplex). Many beet depredators also live on plants belonging to an allied family—the Amaranths—which contains many common weeds, including pigweed, as well as a few ornamental forms.

One of the earliest instances of injury to the beet reported in America is that furnished by our first economic entomologist, Harris,[a] in 1841. In quite recent years, however, several species have been so prominent as pests in fields of sugar beet that they have received names indicative of their beet-feeding habit, while a few take their common names from spinach. Among these are the beet army worm,[b] the beet webworm,[c] the beet or spinach leaf-miner,[d] spinach flea-beetle,[e] beet carrion beetle,[f] beet aphis,[g] European beet tortoise beetle,[h] and two species of leaf-beetles.[i] Of the various insects known to live on this plant, not more than about one-third, or 40 or 50 species, can be classed as noticeably destructive to it.

It is difficult to decide at this time, owing to the lack of study given the subject over the entire country where beets are raised, which forms of insects are of the highest importance. The different insects which have been mentioned specifically are more attached to beet and spinach than to other plants, and the greatest losses, if we take the entire country into consideration, are probably due to the ravages of flea-beetles, but they, as well as cutworms and similar groups, are so periodical or, more properly speaking, irregular in their depredations that an exact estimate of their economic status can not be made. Different species of leaf-beetles and caterpillars other than cutworms do more or less injury, and several blister beetles devour the foliage of sugar and table beets freely; most forms of the last, however, usually make their appearance so late in the season that, although defoliation may be excessive, comparatively little damage is accomplished. The same is true of some species of grasshoppers.

Beets until recently were comparatively free from subterranean insect enemies, but there are two forms of common farm pests, white grubs and wireworms, that affect underground portions of the plants and occasionally injure them; in addition to these, some kinds of root-lice and mealy-bugs injure the roots by suction, rendering them small

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[a] The species mentioned is the zebra caterpillar (*Mamestra picta*). Rept. Ins. Mass. Inj. to Veg., p. 328.

[b] *Caradrina exigua.*

[c] *Loxostege sticticalis.*

[d] *Pegomya vicina.*

[e] *Disonycha xanthomelæna.*

[f] *Silpha opaca.*

[g] *Pemphigus betæ.*

[h] *Cassida nebulosa.*

[i] *Monoxia puncticollis* and *M. consputa.*

and soft or spongy when they do not kill them outright. Some other sucking insects—plant-lice, plant-bugs, leaf-hoppers, and the like—occasionally injure the plants by absorbing their vital juices, but with some notable exceptions they are comparatively unimportant as beet pests.

Many of the most destructive or best known sugar-beet pests have received more extended notice in recent publications of the Division of Entomology, notably in Bulletins 19, 23, 29, 33, and 40, new series (from which the present article has been largely collated), in addition to other publications which have been cited in the introductory paragraph and others which will be mentioned in connection with the different species as they are considered.

In indicating methods of control to be observed for insects which are not special enemies of the sugar beet, it has been found necessary, owing to our somewhat imperfect acquaintance with all of the conditions which surround attack, to treat the subject in a general manner. The remedies for different forms and classes of insects are therefore considered as they occur upon the farm. Where deemed advisable, however, an effort has been made to limit remedial directions to the occurrence of many of these insects in fields of sugar beet. It may therefore be stated that as a general rule remedies prescribed for insects as these occur on their favorite food plants also serve for their destruction on other crops. Exception is made of insects such as the southern corn root-worm, which is a prime enemy of corn, though the beetles are usually to be found in beet fields, since the elaborate treatment which is often necessary in combating this pest on corn, need not be employed on beets and other crops where its injuries are comparatively insignificant.

LEAF-BEETLES AND FLEA-BEETLES.

Several leaf-feeding beetles of the family Chrysomelidæ, known as leaf-beetles and flea-beetles, are quite conspicuous as enemies of the sugar beet. Three of the leaf-beetles are apparently peculiar to beets among cultivated plants, injuring them both in the adult and the larval stage, while numerous flea-beetles, although as a rule general feeders, are even more destructive by attacking the plants early in the season, when they are least able to withstand injury.

THE LARGER SUGAR-BEET LEAF-BEETLE.

(*Monoxia puncticollis* Say.)

With the cultivation of the sugar beet in the West there has come to prey upon it a moderate-sized leaf-beetle, known in parts of New Mexico as the "French bug."[a] Its presence in beet fields was first

[a] See the author's article, Bul. 18, Div. Ent., U. S. Dept. Agr., p. 95.

noticed simultaneously in that Territory and in Colorado in 1898, when it did serious injury to crops. The beetles are gregarious, sometimes occurring "in swarms like blister beetles." Their brownish gray eggs are deposited in irregular masses, usually on the under sides of leaves. They hatch in about six days, and their larvæ or young commence feeding at once, continuing for nine or ten days, when they dig their way into the ground, a few days later coming forth as beetles. Although the beetles do much injury, the principal damage is sometimes accomplished by the larvæ, hundreds being found on a single small plant, which is either consumed or so injured that it shrivels and dies. In 1902 this insect did considerable injury to sugar beet in Colorado.[a] It feeds on several wild plants, blites (*Dondia americana* and *D.*

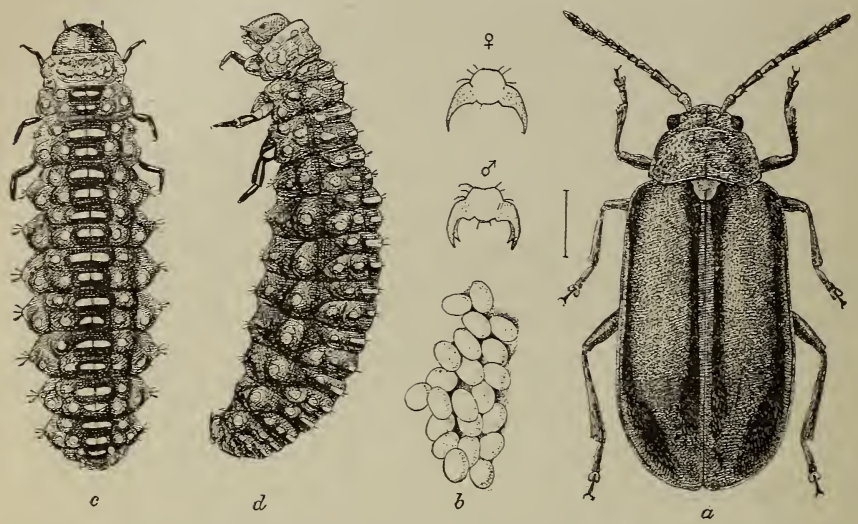

FIG. 1.—*Monoxia puncticollis: a*, female beetle; *b*, eggs; *c*, larva, dorsal view; *d*, larva, lateral view; ♂, claw of male; ♀, claw of female—all much enlarged, male and female claws more enlarged (author's illustration, Division of Entomology).

depressa), Russian thistle (*Salsola tragus*), and saltbush (*Atriplex argentea*), is double-brooded according to Prof. C. P. Gillette,[b] and occurs throughout the summer.

This species is related to the imported elm leaf-beetle, but is larger and differently marked. The beetle is quite variable, both as regards the markings and size, the length being from one-fourth to one-third of an inch. It is of oblong form, narrow in front. The color varies from pale yellow to entirely black, while the elytra or wing-covers are more or less distinctly striped. The surface of the thorax is coarsely and irregularly punctate. Five varieties or races are recognized. The beet-feeding form is illustrated in figure 1, *a*. The larva, shown in the same illustration, *c*, *d*, measures when full grown about one-third

[a] Bul. 40, Div. Ent., pp. 111–113.

[b] Twenty-fourth Rept. Colo. Agric. Expt. Sta., 1902, pp. 108–111.

of an inch in length. The general color is nearly uniform dark olive brown, the conspicuous piliferous tubercles being pale yellow, and the head and portions of the legs black. The eggs (*b*) are dull brownish gray, and the surface, as seen through a lens, is covered with septagonal and hexagonal areas.

A common variety of this species, not thus far noticed, however, in beet fields, is illustrated in figure 2. It has been observed in Nebraska, Texas, and Florida.

Remedies.—This and the Western beet leaf-beetle are apt to become important enemies of sugar-beet culture unless remedial measures are instituted. The general methods for the control of leaf and flea-beetles (see page 169) are all applicable, but a few remarks should be added in regard to particular remedies for these two species. Paris green, London purple, and paragrene have all been employed against the larger species with apparently good results when applied dry, mixed with flour, in the same manner as for the Colorado potato beetle. Against the Western species a spray of Paris green with whale-oil soap has been used with success, the beneficial effect lasting about six weeks, the beet leaves not being injured. There is no especial advantage in the addition of the soap, and the arsenical used alone or with Bordeaux mixture would have answered still better.

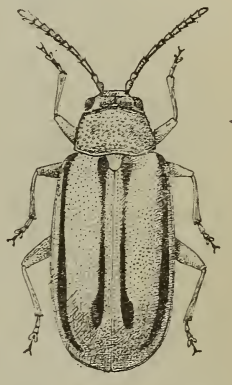

FIG. 2.—*Monoxia punctticollis*, variety—5 times natural size (author's illustration, Division of Entomology).

Two interesting facts brought out in the course of Professor Gillette's observations on the larger insect in Colorado are of value as indicating methods of control. It was observed that the beetles accumulated quite largely upon "mother" beets early in the spring, which suggests that if a few beets be left in the ground over winter they will serve as trap crops for the protection of the younger plants in spring. It was noticed also that the insect appeared to confine its injuries to plants growing in alkali ground or in close proximity to such soil. Hence such ground is to be avoided for the cultivation of beets.

THE WESTERN BEET LEAF-BEETLE.

(*Monoxia consputa* Lec.)

Garden as well as sugar beets are injured by this species, particularly along the Pacific coast. It first attracted attention in the years 1890 and 1891 in Oregon, where it did considerable injury (F. L. Washburn, Bul. 14, Oregon Agl. Expt. Sta., p. 11.). It eats holes through the leaves, in some instances leaving only a network of the original leaf, and this seriously interferes with the growth of young plants, which are sometimes killed.

This beetle (fig. 3) is smaller than the preceding, measuring only about one-sixth inch in length; is pale yellowish brown in color and moderately variable, some individuals being plain, while others are marked with black spots arranged in nearly regular series.

It is a Western species, but ranges as far eastward as the Dakotas, and is found in Montana, Utah, Colorado, Kansas, Arizona, and the Pacific States. There is no record of injury by the larva, but there is little doubt that it also affects this plant, and in much the same manner as does that of the larger sugar-beet leaf-beetle. Injury has been noticed in Oregon toward the end of August, continuing for six or eight weeks.

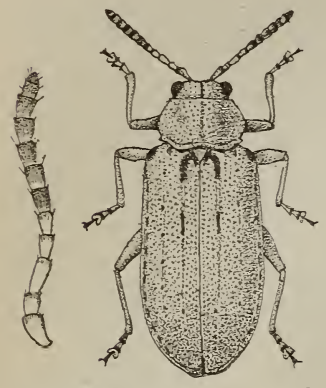

FIG. 3.—*Monoxia consputa:* beetle, 8 times natural size; antenna at left highly magnified (original, Division of Entomology).

THE SOUTHERN CORN ROOT-WORM.

(*Diabrotica 12-punctata* Ol.)

As this species is present everywhere in beet fields the year round, it is familiar to most beet growers. The adult is best known in the North as the twelve-spotted cucumber beetle, from its partiality for flowers of cucumber and related plants. In the South the young or larva is called the "bud worm" from its pernicious habit of burrowing into and eating young cornstalks soon after the germinating period.

The beetle (fig. 4) measures nearly one-fourth of an inch in length, is yellowish-green in color, and the elytra or wing-covers are marked with twelve black spots.

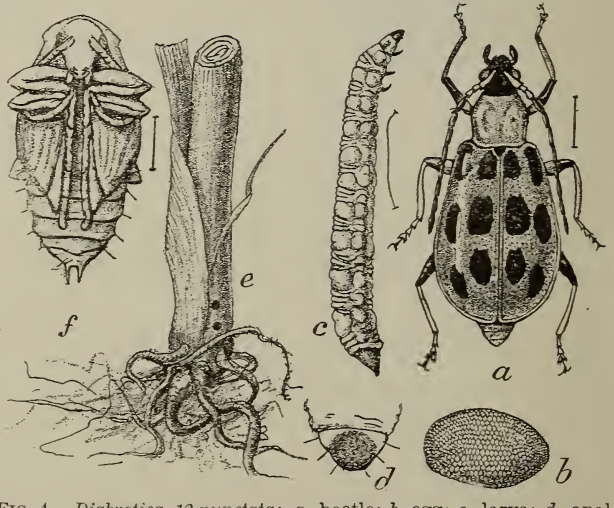

FIG. 4.—*Diabrotica 12-punctata: a*, beetle; *b*, egg; *c*, larva; *d*, anal segment of larva; *e*, work of larva at base of cornstalk; *f*, pupa—all much enlarged except *e*, which is reduced (reengraved after Riley, except *f* [original], Division of Entomology).

This beetle is practically omnivorous, feeding upon almost any form of vegetation upon which it happens to alight. Although very fond of flowers, it is liable to attack any portion of a plant, finding food on the foliage and other portions of most garden and many field crops, the flowers and leaves of fruit trees, and the bloom of many ornamental plants. The larva develops on the roots of grasses, as well as corn, and even on beans and some other plants. The beetles have been

accused of being carriers of various plant diseases, and probably with justice, since they have a habit of flying frequently from one plant to another, feeding on each in turn. In the leaves of beets and other vegetables they make many small, irregular holes, and are capable of doing considerable damage when occurring abundantly on young plants. It is not known how many generations are produced during the year, but as the beetle is one of our earliest as well as latest species, it seems probable that two or perhaps three generations may be produced annually, at least in the more southern States.

Remedies.—Ordinary leaf-beetle remedies are applicable to this species in its occurrence on beets. On cucumber and other cucurbits, however, it is more troublesome, and must be treated in about the same manner as the striped cucumber beetle (see Circular No. 31, Div. Ent.). On corn it is still more difficult to control the root-worms, and this subject will be reserved for discussion elsewhere. The results of experiments with remedies are given in an article on this species by A. L. Quaintance (Bul. 26, n. s., Div. Ent., pp. 39–40).

THE COLASPIS ROOT-WORM.

(*Colaspis brunnea* Fab.)

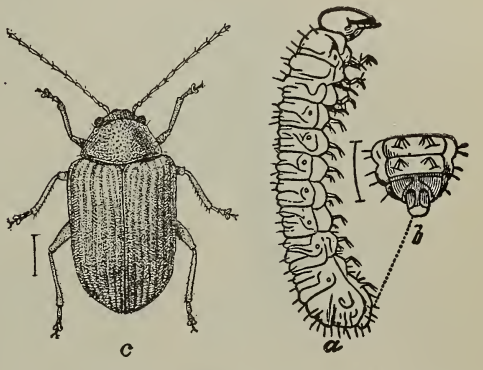

FIG. 5.—*Colaspis brunnea: a*, larva or root-worm; *b*, anal segment of larva from above; *c*, beetle—all enlarged (*a*, *b*, after Riley; *c*, original, Division of Entomology).

This species is best known as a depredator upon grape and strawberry, on which the larvæ also subsist, whence two of its vernacular names of grapevine colaspis and strawberry root-worm, but it has frequently been noticed on sugar beet in Nebraska and Illinois. It is also often found attacking the foliage of beans.

The beetle is common and well known. It is exceedingly variable, but typical specimens are yellowish or pale brown, dull or moderately shining, the elytra and legs are a little paler than the other portions. The form is oval, slightly oblong, and moderately convex, the general appearance being about as represented at figure 5, *c*. The larva[a] is a white cylindrical grub, about an eighth of an inch long, with a yellowish-brown head. The pupa is also white and has simple, incurved anal hooks.

This beetle has been recorded as doing more or less injury to several plants other than those mentioned, including potato, buckwheat, corn, clover, beans, cowpea, muskmelon, cotton, and some wild plants, including tick trefoil and New Jersey tea, and the leaves or blossoms of apple, pear, and willow. The larva has also been observed

[a] For particulars the reader is referred to 22d Rept. State Ent. Ill., 1903, pp. 145–149; also Bul. 9, n. s., Div. Ent., p. 21.

feeding on the roots of timothy and other grasses, and Indian corn, in addition to clover, strawberry, and grape, which would lead to the belief that the species might have been originally a grass-feeding one.

There is little doubt that the insect is single-brooded, and it has been surmised that it hibernates as a partly grown larva. The beetles which are to be found from June to September probably also hibernate.

THE BEET TORTOISE BEETLE.

(*Cassida nebulosa* Linn.)

An illustration of this species (fig. 6) and a short notice of it is presented, for the reason that it is one of the few insects which derive their common names from the beet, and because it is destructive to sugar beet in Europe. There is, moreover, some likelihood of its becoming a pest in our own country if it should ever be able to obtain a permanent foothold here. It is reported as having been observed in California in 1894, but as we have heard little of the insect since that time some doubt exists as to its actual establishment in America. It ranges through Europe and in Asia from Persia to Siberia, and it may be that it is destined to become cosmopolitan. Therefore beet growers should be warned against it. In Europe this beetle feeds on lambsquarters, Atriplex, and related plants, but when these plants become exhausted it devastates large areas of sugar beets. There are said to be two generations of the beetles produced annually, one appearing in August, the other in the autumn. The beetle is about one-fourth of an inch long and yellowish gray or pale green in color.

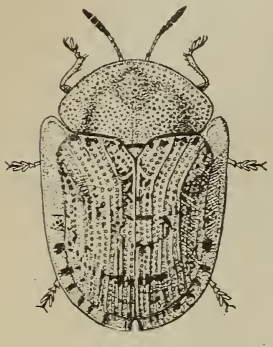

FIG. 6.—*Cassida nebulosa:* beetle, about 4 times natural size (original, Division of Entomology).

Remedies.—The same remedies advised against other leaf-beetles would apply to the present species.

THE SPINACH FLEA-BEETLE.

(*Disonycha xanthomelæna* Dalm.)

Flea-beetles are among the most important enemies of the sugar beet, and of growing importance, as recent reports bear testimony. No less than a score of species have been observed to attack beets. Among the most destructive of these are the spinach flea-beetle, the pale-striped flea-beetle, and the black and red-headed flea-beetles, well-known forms in the East; but in some portions of the West and elsewhere others do more damage. They are most troublesome on very young plants.

Reports of injuries by the spinach flea-beetle to cultivated plants

are rapidly increasing, although it continues to live by preference on weeds and wild plants. The crops most injured are beets, spinach, and saltbush; and natural food plants are chickweed and lambsquarters. The leaves of these plants are riddled with holes, chiefly the work of the larvæ, but also of the beetles, and gardeners complain that spinach may be so badly worm-eaten that it is impossible to offer it for sale. Considerable injury to beets was observed by the writer in 1900, and during 1902 and 1903 the insect has been the most conspicuous species on sugar beet in and near the District of Columbia.

The larvæ, as well as beetles, drop quickly upon being disturbed, and as the former are inconspicuous in appearance, and the latter feign death, the miscreants are apt to elude recognition, the early injury produced being frequently ascribed to cutworms and the later damage to other insects. Frequently from 15 to 20 larvæ live on a single leaf. They feed mostly on the under surface.

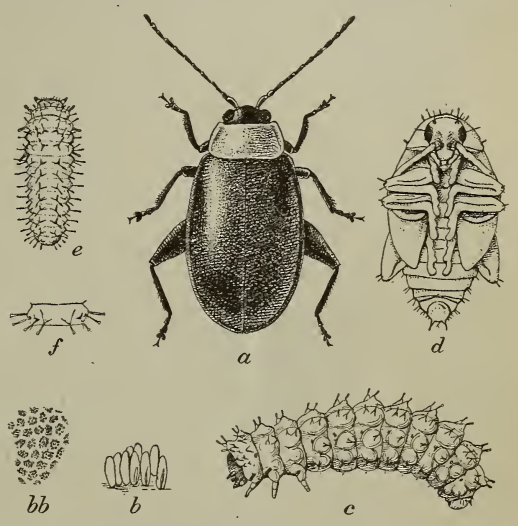

FIG. 7.—*Disonycha xanthomelæna: a*, beetle; *b*, egg mass, showing mode of escape of larva at right; *bb*, sculpture of egg; *c*, full-grown larva; *d*, pupa; *e*, newly hatched larva; *f*, abdominal segment of same—*a*, *c*, *d*, five times natural size; *b*, *e*, more enlarged; *bb*, *f*, still more enlarged (author's illustration, Division of Entomology).

The beetle (fig. 7, *a*) is shining black, sometimes with a greenish or bluish luster. The prothorax and abdomen are red or reddish yellow, and the legs and antennæ pale yellowish. It measures less than one-fourth of an inch. The buff or orange eggs (*b*, *bb*) are deposited in masses. The mature larva (*c*) as it occurs on sugar beet is dull leaden gray, with darker head and still darker brown mouth parts, but on red and purple beets it takes on the color of the plant attacked. This is a native species and of exceptionally wide distribution, its habitat extending from New England to Montana, and from British America to Florida and Texas. It is one of our earliest spring visitors, appearing in the first warm days of March in the Atlantic States, and continuing abroad some years through November. Two generations occur in the District of Columbia, the first usually produced on chickweed, and later ones on beets, spinach, and other plants. It is a prolific insect, as many as 180 eggs having been observed to be deposited by a single female.[a]

[a] A more complete account of this flea-beetle is given in Bul. 19, n. s., pp. 80–85.

THE PALE-STRIPED FLEA-BEETLE.

(*Systena blanda* Mels.)

This species, a beet feeder of long standing, has in recent years come to the front as an important enemy to sugar beets, and table beets are also affected. In 1899 and 1900 much injury was done to sugar-beet fields in Michigan, some having been practically destroyed while the plants were quite young. During 1900 much injury was done in Colorado, the beetles appearing in swarms of millions and practically killing plants of two or three weeks' growth. Older plants were considerably checked in development, but not destroyed. The next year beets were injured in South Carolina and Indiana.

This is one of our commonest, most nearly omnivorous, and most destructive flea-beetles. It measures about an eighth of an inch, is cream-colored, with nearly black abdomen and eyes, and striped wing covers (fig. 8, *b*). The larva is white and slender, with light brownish-yellow head. It is an American species and of rather wide distribution, from New Jersey and Pennsylvania southward to Georgia, and westward to California.

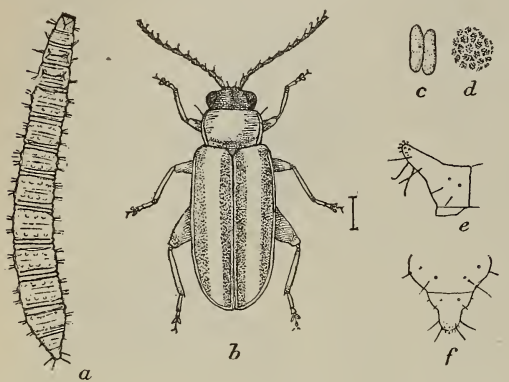

FIG. 8.—*Systena blanda: a*, larva; *b*, beetle; *c*, eggs; *d*, sculpture of egg; *e*, anal segment, from side; *f*, same from above—*a–d*, six times natural size; *e*, *f*, much enlarged (author's illustration, Division of Entomology).

The pale-striped flea-beetle, though a general feeder, is particularly fond of the foliage of beets and beans. Potatoes and corn it also injures very much, while considerable damage to melons and other cucurbits, turnips and other crucifers, tomatoes, peas, carrots, and eggplant has been observed. The beetles also attack strawberry, clover, cotton, oats, and peanuts, and injure the leaves of pear, as also pear grafts, by eating out the terminals, thus stunting the growth of the trees. They sometimes do severe injury in three or four days.

The species hibernates as a beetle, and appears above ground in the vicinity of the District of Columbia early in June; egg laying evidently continues through that month and to the middle of July, if not two or three weeks later; injury is usually due to the beetles upon their first appearance; and almost any valuable crop may be injured, either in the absence or presence of the wild food plants.

The larvæ live below ground, and have been observed by the writer and others feeding on the roots of corn, lambsquarters, and Jamestown weed. They probably live also on pigweed (Ambrosia), cocklebur (Xanthium), and other weeds, as the beetles are commonly found on these plants.

THE BANDED FLEA-BEETLE.

(*Systena tæniata* Say.)

The banded flea-beetle also frequently attacks beets, beans, and other vegetables, particularly in the West and Southwest. It has similar habits to the preceding species and similar structure; it was, in fact, until quite recently very generally confused with the pale-striped form, and many references to injuries by this species are really due to the latter. Like the latter it varies considerably as regards color and punctation. It is polished black, with white stripes. A common dark form of the beetle is shown in figure 9.[a]

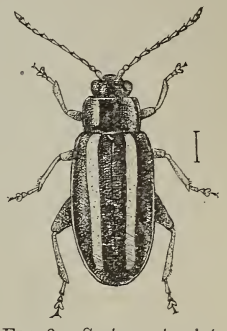

FIG. 9.—*Systena tæniata*, dark variety—about 6 times natural size (author's illustration, Division of Entomology).

THE RED-HEADED FLEA-BEETLE.

(*Systena frontalis* Fab.)

This species (fig. 10) resembles in its habits the two flea-beetles that have just been mentioned. Its color is shining black throughout except the major portion of the head, which is red. It has been known as an enemy of beets since 1891. It also attacks potato and beans, but is not restricted to vegetable crops, being quite fond of the foliage of fruits, including grape, gooseberry, pear, and others. It inhabits practically the entire arable region east of the Rocky Mountains, including southern Canada and the Southern States (Bul. 33, n. s., Div. Ent., pp. 111–113).

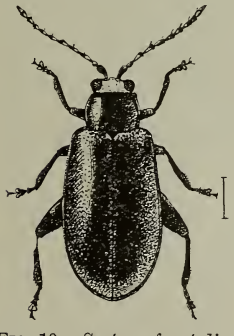

FIG. 10.—*Systena frontalis*—much enlarged (author's illustration, Division of Entomology).

THE SMARTWEED FLEA-BEETLE.

(*Systena hudsonias* Forst.)

From the red-headed flea-beetle this differs in being uniformly shining black. Otherwise the two species are very similar. Taken all in all, it is perhaps the most abundant of the flea-beetles which have been mentioned, but, although it shows a fondness for a number of crop plants, including sugar beet, potato, grape, beans, and sweet corn, it is much more confined to weeds (L. c., pp. 113–114).

The larval habits of the three species last mentioned have not been positively ascertained, but there is little doubt that they will be found to be much the same as those of the pale-striped flea-beetle, since the beetles of all of them occur in greatest numbers on the same species of weeds, and, even when occurring in moderate abundance, seem to show little preference.

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[a] This and the preceding species are discussed in Bul. 23, n. s., Div. Ent., p. 23.

THE WESTERN CABBAGE FLEA-BEETLE.

(*Phyllotreta pusilla* Horn.) [a]

In some of the Western States not inhabited to any extent by any of the preceding species there is a small dark-colored flea-beetle uniformly deep polished olive green, with the surface irregularly punctate (fig. 11) which, as its English name indicates, affects more particularly cabbage and related crops. During 1901 it was observed doing considerable damage to sugar beet in portions of Colorado. It prefers the younger plants, and as instance of its destructiveness one grower reported that he had not raised a turnip for seven years on account of its ravages. Between 10 and 20 acres of corn were reported destroyed on one farm in twenty-four hours, the beetles sometimes coming in swarms like black clouds and covering the plants. This flea-beetle ranges from the Dakotas to Mexico, and westward to southern California, being found in numbers at high elevations in the Rocky Mountain region.

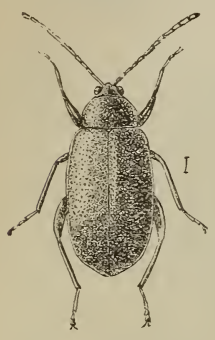

FIG. 11.—*Phyllotreta pusilla*—much enlarged (after Riley, Division of Entomology).

REMEDIES.

The arsenicals, especially Paris green, are the most useful remedies for leaf-feeding beetles, and since Bordeaux mixture is extremely distasteful to flea-beetles, this, if mixed with the insecticide and applied as a spray, is more effective than when the arsenical is used dry. Against some species, however, Paris green mixed with 20 parts of flour and dusted on infested plants has been found satisfactory, while kerosene emulsion and even strong soap washes have been found useful in combatting others. When the plants are quite young the spray can not be so well used as after they have attained larger growth, but the dry mixture can then be applied with best results. Bordeaux mixture used alone is valuable as a deterrent.

Clean culture is also of the greatest value. It consists in keeping down weeds which serve as food for the beetles and as breeding places for their larvæ. Against the spinach flea-beetle we have to destroy the chickweed and lambsquarters of the vicinity and to avoid the planting of beets and spinach in ground which has become overgrown with these plants. For the pale-striped flea-beetle, lambsquarters, cocklebur, and pigweed should be destroyed, while for insects like the smartweed flea-beetle practically all weeds in the vicinity must be pulled up and destroyed, as this insect feeds on nearly all forms of useless vegetation. The time for performing this work varies according to

[a] In early publications, for example, in the Report of this Department for 1884, p. 308, this insect was mentioned as *Phyllotreta albionica* owing to the fact that the two species had not been separated, *albionica* being the older name.

the species concerned, and with locality and season. In general terms, it may be said that the best time is after the beetles have laid their eggs and before the young or larvæ have attained full development. For most species this would be about three weeks after the first appearance of the beetles in numbers. A spraying of the upper surface is sufficient for most flea-beetles, but for the spinach flea-beetle it is necessary to apply a spray to both the under and upper surfaces in order to reach the larvæ which feed in exposure on the lower surfaces of plants.

THE BEET AND SPINACH CARRION BEETLES.

Among insects particularly attached to beet and spinach are two, known respectively as the beet and the spinach carrion beetles. They are nearly unique among carrion beetles (Silphidæ) which subsist chiefly on decomposing animal matter, this being the normal habit of the family. The two species in question are also found under carcasses and in garbage. From their dual habit of living both on carrion and on beets and spinach they derive their English names.

THE BEET CARRION BEETLE.

(*Silpha opaca* Linn.)

This species is mentioned in the preface as particularly attached to the beet. In some parts of Europe it is a very serious pest, more particularly in Germany, France, Austria, and England, although it is rather generally distributed on that continent, occurring in Siberia. In Germany it has been described as "by all odds the most troublesome pest" with which beet growers have to deal. The species was identified in 1880 from specimens collected in California and "Hudson Bay," and it seems probable that it was introduced on the Pacific coast, and has recently made its way to Nebraska, where it was found attacking beet in 1891.[a] There is some danger that at some future time it may become a more serious pest, such as it now is in its native home.

The beetle is black and of similar appearance to our common carrion beetles. The body is elongate, or oblong-oval, with the sides comparatively parallel. It is much flattened, and the elytra at the sides are thin and slightly reflexed or turned up. There is also a small prominence near the end of each, the middle costa or ridge of the elytron extends nearly to the posterior margin, and the tip of the abdomen is dull red. The length is about three-fourths of an inch.

The larvæ are shining black, and of similar appearance to our common sowbugs (Oniscus), creatures commonly found in fence corners and in cellars, and they, with their parents and others of their kind,

[a] Bruner, Bul. 30 (old series), Div. Entomology, p. 40.

occur under carcasses of small animals, such as rabbits and birds, and in garbage.

The eggs are probably laid usually in decomposing material, but it has not been ascertained where they are deposited in beet fields.

The larvæ are nocturnal, feeding chiefly in the evening and early morning, and concealing themselves during the heat of the day about the roots of the plants affected. They first attack the parenchyma or outer surface of a leaf, leaving the skeleton more or less intact; but when in numbers they consume entire leaves, sometimes eating them down to the ground. Afterwards they attack the roots. Where the leaves are not severely eaten the plants recover, but if the foliage is destroyed the plants usually die. The species is probably single-brooded. As soon as the larvæ become full fed injury ceases and the plants, if not too seriously damaged, begin to take on new growth. Larvæ descend into the soil to a depth of three or four inches and there change to pupæ and afterwards to beetles, in which stage they pass the winter undisturbed and free from natural enemies until the following spring, when they reappear.

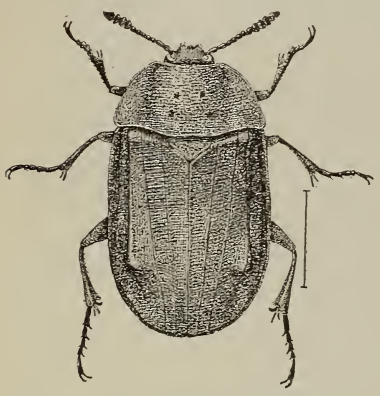

FIG. 12.—*Silpha bituberosa:* adult—much enlarged (original, Division of Entomology).

THE SPINACH CARRION BEETLE.

(*Silpha bituberosa* Lec.)

This species resembles the preceding, both in appearance and habits, but differs in some important particulars, being a native species and restricted, so far as injurious occurrences are concerned, to the Northwest Territories and neighboring portions of British America. It occurs, however, also in northern Kansas, from which State it was originally described in 1859, and in Wyoming and Montana. Unlike the preceding species, it attacks other vegetation than beets, although it seems probable that it fed originally on plants of that family, such as lambsquarters and another weed native to the Northwest (*Monolepis nuttalliana*). Other food plants are squash and pumpkin. The insect seems capable of being quite destructive to all of these crops. Some vines of the pumpkin have been entirely destroyed. In Alberta the larvæ have been reported as swarming in gardens in the spring, devouring leaves of spinach and beet.

The spinach carrion beetle (fig. 12) is much broader than the beet carrion beetle, being more nearly oval, whereas the latter is elongate oval. It measures nearly half an inch and is of the same black color. The larva is polished black and does not appear to have been differentiated from that of the preceding.

In its life history it doubtless closely resembles the European importation in feeding on both carrion and vegetation. Whether or not the beetles also injure plants does not appear to be known. Attack by the larva begins in the latter part of May, extending through June, and probably into July in the more southern and warmer range of the species.[a]

REMEDIES.

The remedies in use against the Colorado potato beetle are applicable to these carrion beetles. Paris green, applied either dry or in spray, as directed for leaf beetles, and clean culture are about all that are necessary, but it is also advised in the treatment of the native species that the weed Monolepis be sown in the vicinity of spinach, beets, and gourd crops subject to attack, to serve as a lure to draw the insects from the crops. On the trap plants they can be more easily destroyed, and by various means.

BLISTER BEETLES.

Blister beetles are among the most conspicuous of all enemies of the sugar beet, no less than a dozen species having been observed doing more or less injury to this crop. One or more species are generally found in beet fields, and, in fact, the arable regions of the United States are probably never free from them. In the East four or five species are common, and in the Southwest there are a few more extremely destructive species. Most blister beetles are better known as potato pests, but next after potatoes beets appear to be the favorite food of many of them. After this they attack other vegetable crops, some favoring beans, peas, and other legumes, while almost any of them will attack whatever comes next in their line of march. They are gregarious, congregating in great numbers, and some have the truly migratory habit, feeding voraciously, running with great rapidity, and flying from time to time. Thus it happens that they frequently descend in such numbers on a field that an entire crop is ruined beyond recovery in a few days, when the insects disappear and are perhaps seen no more until the following year. After the departure of one species of blister beetle another frequently follows, to be replaced by a third, and so on.

Some species, though apparently very destructive, appear so late in the season that, although beet plants are sometimes nearly defoliated, a fair crop may be gathered in spite of the loss of the leaves, a new growth of which is sometimes put forth. The roots, morever, are not touched.

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[a] General accounts of this insect have been published by Dr. James Fletcher. (Rept. Ent. Can. Exp. Farms for 1893 [1894], pp. 20, 21; for 1897 [1898], page 198, etc.)

In their life history blister beetles differ greatly from other Coleoptera in that they undergo a more complicated series of metamorphoses which will be explained and illustrated in the account of the striped blister beetle which follows.

Blister beetles are not an unmixed evil, since they do some good in their larval stage to compensate in a measure for the harm the beetles occasion to our crops, for the habit of the larvæ of destroying grasshopper eggs renders them of material aid in keeping these pernicious insects in check. This is especially true in the Western States, where both blister beetles and grasshoppers abound. But the benefits derived are really more than counterbalanced by the losses occasioned in fields and gardens; hence, insecticides and other measures should be employed to destroy the beetles when they occur in harmful numbers.

As blister beetles are to be found in practically all fields of sugar beet, and are among the most prominent enemies of this plant, it is purposed to consider several of the most abundant species.

THE STRIPED BLISTER BEETLE.

(*Epicauta vittata* Fab.)

Before the advent of the Colorado potato beetle in the East this was our most destructive potato insect, and probably because it is also

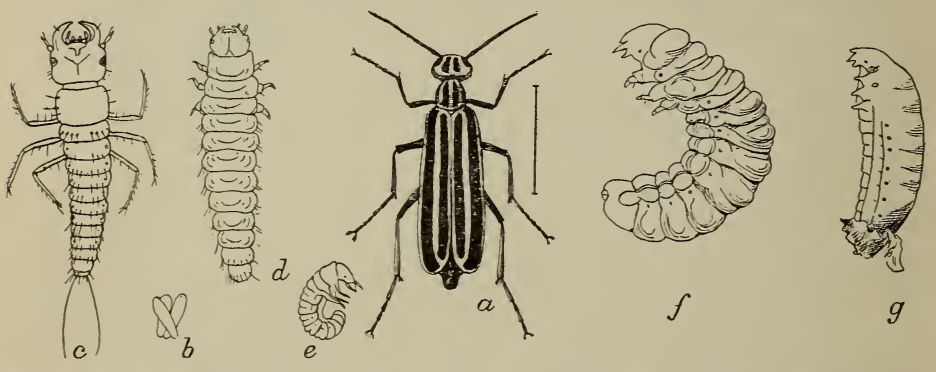

FIG. 13.—*Epicauta vittata: a*, female beetle; *b*, eggs; *c*, triungulin larva; *d*, second or caraboid stage; *e*, same as *f*, doubled up as in pod; *f*, scarabæoid stage, *g*, coarctate larva—all except *e* enlarged (after Riley, except *a*; original, Division of Entomology).

striped is often called the "old-fashioned potato bug." It is abundant and well known east of the Rocky Mountains, of common occurrence on sugar and table beets, and as its life history is typical of injurious forms of this group it may properly receive first attention. The beetle can be easily identified by means of the illustration (fig. 13, *a*). It is about half an inch long, and there are two black stripes on each wing-cover, alternating with yellow.

The eggs are laid in small masses (*b*) on plants or upon the ground. From each hatches a small long-legged larva, called a "triungulin" (*c*), which runs actively about in search of a grasshopper egg pod, which

it enters and devours the contents. After a time it casts its skin and assumes what is termed the "caraboid" or second larval stage (*d*, *e*); and with another molt it resembles a white grub, the "scarabæoid" larval stage (*f*). When a larva has finished its quota of locusts' eggs it undergoes a fourth molt and forms within its own skin what is known as the coarctate larval stage (*g*), and in this condition usually passes the winter. In the spring another larval molt takes place, and with the last shedding of its skin the insect enters upon the true pupal stage, and in due time transforms to a beetle.[a] The pupa of a related species is illustrated in figure 16.

This species also does injury to beans, peas, tomato, turnip, radish, melons, corn, clover, and alfalfa. It was the cause of a serious outbreak in Michigan in the latter part of June and the first part of July, 1900. Corn plants about six inches high and clover suffered severely, the reason being that the potatoes grown there, being all late varieties, had not come up, and more palatable food was not available.

The writer has seen hordes of this species traveling in much the same manner as army worms, and feeding with such voracity that scarcely a beetle flew when plants on which they were congregated were approached. When a "flock" starts to feed on one form of food plant it continues on this until all plants in sight have been devoured, when the beetles have recourse to other plants that are palatable to them. This trait has also been observed in other species, especially in the margined blister beetle.

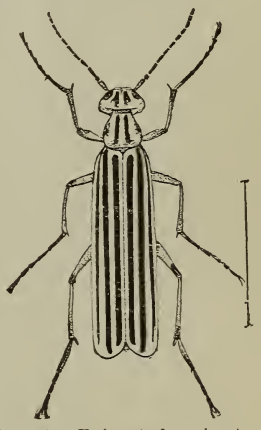

FIG. 14.—*Epicauta lemniscata*—enlarged (original, Division of Entomology).

THE THREE-LINED BLISTER BEETLE.

(*Epicauta lemniscata* Fab.)

This blister beetle very closely resembles the preceding; in fact, the two are frequently confounded, and injuries inflicted by one species are apt to be attributed to the other. The form under consideration (fig. 14) is a little more slender than the striped blister beetle, has three stripes on each wing-cover instead of two, and is a little longer. It is very abundant southward, and, although perhaps primarily a potato pest like most of our noxious blister beetles, is also extremely fond of beets. During different years we have received complaints of this species and of extensive damage in Florida, South Carolina, and Texas to cabbage, potato, squash, and to beet tops, as also to alfalfa. In the vicinity of Horton, Tex., in 1896, the last-mentioned crop was said to be a failure, owing to the depreda-

[a] Particulars in regard to these peculiar transformations are given in articles by C. V. Riley, Am. Nat., Vol. XII, p. 286; Vol. XVII, p. 790.

tions of this blister beetle. During 1902 we received reports of injuries by it in Florida to tomato, potato, sweet potato, eggplant, turnip, cabbage, cowpea, and beet, beet tops being preferred to all other vegetables.

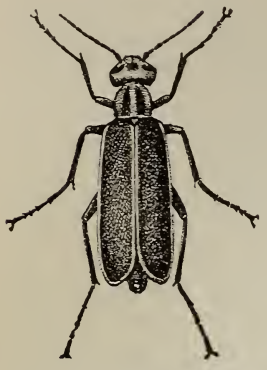

FIG. 15.—*Epicauta marginata*—enlarged (original, Division of Entomology).

THE MARGINED BLISTER BEETLE.

(*Epicauta marginata* Fab.)

One of the commonest Eastern species is the margined blister beetle (figs. 15 and 16). In the writer's experience it appears to be more partial to beets than to any other useful plant. Entire plantings are often seen almost completely defoliated. In a climate like that of the District of Columbia, it occurs so late that no material harm is done, the roots having made nearly complete growth when the insect appears in its greatest abundance, in late July and in August. It is known as an important enemy of beans, potato, and tomato, and attacks aster, clematis, and other ornamental plants.

FIG. 16.—*Epicauta marginata*: pupa—enlarged (original, Division of Entomology).

THE GRAY BLISTER BEETLE.

(*Epicauta cinerea* Forst.)

This species (fig. 17) is of the same form and general structure as the preceding, but is of a uniform gray color, lacking the sutural and lateral margins which give the name to the margined blister beetle. The habits of the two species are practically identical; in fact, the latter is believed by some to be only a variety of the margined species.

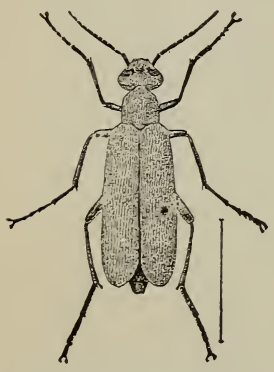

FIG. 17.—*Epicauta cinerea*—about twice natural size (original, Division of Entomology).

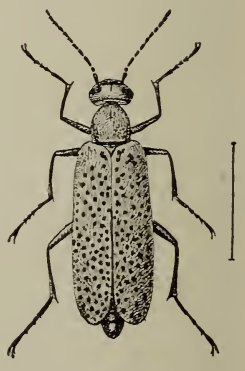

FIG. 18.—*Epicauta maculata*—nearly three times natural size (original, Division of Entomology).

THE SPOTTED BLISTER BEETLE.

(*Epicauta maculata* Say.)

The southwestern portion of the United States is the home of many species of blister beetles not found in the North and East. Among the most abundant of these is the spotted blister beetle (fig. 18). Its body is covered with fine gray hairs, with small rounded areas on the elytra, through which the

natural black of the body shows, giving it the appearance of a gray insect finely dotted with black. It is more or less abundant from Texas and New Mexico northward to South Dakota, and in California and Oregon. It has been known as a beet pest since 1875,[a] and was reported very generally upon sugar beet, potato, and clover in South Dakota in 1897.[b] In August, 1902, Mr. J. L. Webb observed numbers eating leaves of beet at Elmore, S. Dak.

FIG. 19.—*Epicauta pennsylvanica*—enlarged (original, Division of Entomology).

THE BLACK BLISTER BEETLE.

(*Epicauta pennsylvanica* De G.)

The black blister beetle (fig. 19) is a familiar object to nearly everyone from its occurrence on golden-rod, aster, and related wild plants, while the farmer is quite too well acquainted with it as an unwelcome visitor to his potato patch and to various other vegetables. Florists know it under the name of "aster bug," from the severe injuries which it does to asters and which they are unable entirely to prevent. It is uniformly black, without polish, and its length varies from a little more than a quarter to half an inch. It is well distributed in the region east of the Rocky Mountains, and does most injury between the Atlantic States and Texas. Its time of appearance is more or less coincident with the blossoming of the golden-rod, from June to October according to locality, and as a rule it appears later than other species. It is one of the worst insect enemies of potato, beet, and aster, and is also destructive to carrots, beans, cabbage, corn, mustard, clematis, zinnia, and other flowering plants.

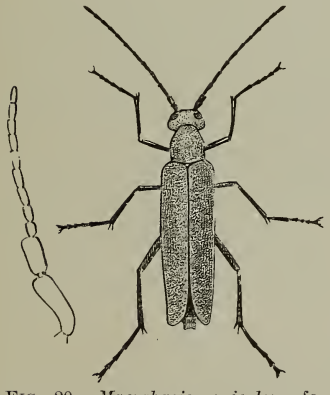

FIG. 20.—*Macrobasis unicolor:* female beetle at right, twice natural size; male antenna at left, greatly enlarged (author's illustration, Division of Entomology).

THE ASH-GRAY BLISTER BEETLE.

(*Macrobasis unicolor* Kby.)

This is one of our commonest Eastern species (fig. 20), and although most destructive to beans, peas, and other leguminous plants, is also a serious enemy of beets, potato, and tomato, and attacks besides sweet potato and some flowering plants.[c]

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[a] Packard, U. S. Geol. Surv. for 1875, p. 731.

[b] D. A. Saunders, Bul. 57, So. Dak. Agl. Ex. Sta., p. 52.

[c] Yearbook U. S. Dept. Agr. for 1898, pp. 249–250.

THE IMMACULATE BLISTER BEETLE.

(*Macrobasis immaculata* Say.)

As with some of the following species, this insect, although common, has not been much studied; but we know of its having injured beets in Kansas as early as 1897, and during 1902 it was destructive to sugar beet in Colorado. Among other food plants are potato, tomato, and cabbage. It is one of our largest blister beetles, and is gray or yellow in color.

THE TWO-SPOTTED BLISTER BEETLE.

(*Macrobasis albida* Say.)

During 1902 this blister beetle was destructive in Indian Territory, in one case devouring a field of sugar beets in a single day. Although an extremely common species from Kansas to Texas and New Mexico, little has been published in regard to its habits until very recently. Like others of its kind it favors vegetable crops, which include tomato, potato, and some others. It is evidently an old beet enemy, as we have record of its being very injurious to this crop in Kansas a decade earlier than the case reported.

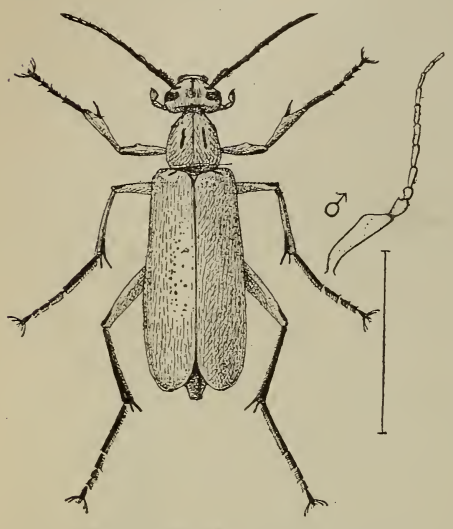

FIG. 21.—*Macrobasis albida:* twice natural size (original, Division of Entomology).

This is also a large species (fig. 21), gray or yellowish in color, with the thorax marked with two nearly parallel lines. It measures about an inch or an inch and a half in length.

THE SEGMENTED BLACK BLISTER BEETLE.

(*Macrobasis segmentata* Say.)

Injury by this blister beetle to beets was reported to this office in 1897, when a considerable proportion of crops of beets, as well as potato, tomato, and cabbage, was being destroyed in Kansas, the beetles being described as coming in large swarms, settling down in fields, and devouring and ruining crops in a few hours. It is one of the larger species of the group, sometimes attaining a length of about an inch. It is of robust form, uniformly dull black, except for an occasional narrow fringe of cinereous hairs on the base or apex of the thorax. Its range extends from Kansas well into Mexico.

NUTTALL'S BLISTER BEETLE.

(*Cantharis nuttalli* Say.)

This species has several times been noted as injuring beets. The beetle (fig. 22) is large and beautiful, usually of a bright metallic green, the head and thorax having a coppery luster, the wing-covers often purple. Its habitat extends from the Mississippi region to the Rocky Mountains and from Canada to Nebraska.[a]

Notes on the habits of this and several other species which have been considered are published in Bulletin No. 40 (new series) of the Division of Entomology (pp. 114–116).

REMEDIES.

Paris green is one of the best remedies for blister beetles when they occur on beets, potatoes, and most other crops. It may be applied dry, mixed with 10 to 20 parts of flour, plaster, or air-slaked lime, or in the form of a spray, also mixed with lime or Bordeaux mixture, at the rate of a quarter of a pound of the poison to 40 gallons of the diluent. Repeated applications are sometimes necessary, since the poisoned beetles are replaced by others.

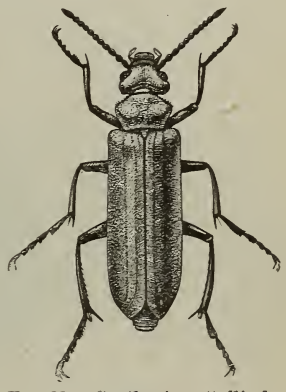

FIG. 22.—*Cantharis nuttalli:* female beetle, one-third larger than natural size (author's illustration, Division of Entomology).

Owing to the rapidity with which many species work, frequently in swarms of thousands, poisons are of little value. We must, therefore, resort to mechanical measures for their destruction, and in the employment of these promptness and thoroughness are the essentials. A remedy which is employed with success in the Western States consists in sending a line of men and boys through infested fields to drive the beetles before them until they alight on a windrow of hay, straw, or other dry vegetable material which has previously been prepared along the leeward side of the field. When the beetles have taken refuge in such a windrow, it is fired and the beetles are burned. The beetles may be destroyed by sweeping them into a net, such as is used by insect collectors, and throwing the captured insects into a fire; or by beating them into large pans of water on which there is a thin scum of coal oil. The latter remedy is successful over small areas.

After what has been said concerning the voracity of these beetles it is almost superfluous to add that whatever remedy is employed should be applied at the outset of attack in order to be of substantial value.

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[a] Yearbook U. S. Dept. Agr. for 1898, pp. 250–251.

SNOUT-BEETLES OR WEEVILS.

A few species of snout-beetles or weevils have been observed attacking sugar beet at various times, but with the exception of the imbricated snout-beetle these insects are of little importance as beet pests; in fact, only one species other than that habitually does material harm to beet plants. The species in question (*Tanymecus confertus* Gyll.) was once notably injurious to sugar beet in Nebraska. It was observed by Professor Bruner first on cocklebur, lambsquarters, and smartweed, after devouring which it completely destroyed the beets in a 12-acre field. Injury by this class of insects in beet fields is by the beetles, the larvæ feeding on the roots of weeds and wild plants.

THE IMBRICATED SNOUT-BEETLE.

(*Epicærus imbricatus* Say.)

The imbricated snout-beetle is a common insect of the field, garden, and orchard, and capable of committing considerable injury to a variety of useful plants including sugar beet and various other vegetables, such as beans and pease.

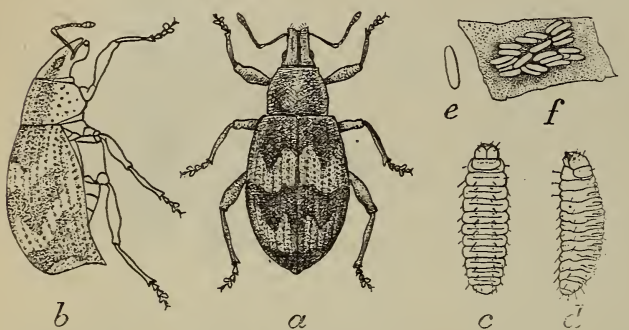

FIG. 23.—*Epicærus imbricatus: a*, female beetle; *b*, same from side; *c*, newly hatched larva; *d*, same from side; *e*, egg; *f*, egg mass.—*a*, *b*, about three times natural size; *f*, two times; *c*, *d*, *e*, more enlarged (author's illustration, Division of Entomology).

It is one of our largest snout-beetles, measuring nearly half an inch in length, and has the body covered with minute imbricated scales (whence the insect's name), the lighter portions appearing brownish gray, and the darker light brown, forming a pattern as shown in figure 23, *a*, and *b*. The head is prolonged into a short broad snout, with elbowed antennæ and the elytra or wing covers terminate in a point. Both sexes are wingless.

It is well distributed, occurring in most States, except the more northern ones, east of the Rocky Mountain range. It does not appear to be found north of the Upper Austral life zone. This distribution includes localities from the neighborhood of New York City southward to Texas and westward to Colorado and Utah.

In addition to the plants that have been mentioned as furnishing food for this species, it has been observed doing more or less injury to onion, radish, cabbage, cucumber, watermelon, muskmelon, squash, corn, potato, and tomato, among vegetables; apple, cherry, and pear trees; raspberry, blackberry, and gooseberry bushes; and to feed on grasses and clover, and some forms of weeds.

The larva is subterranean in habit, but the mature larva and the pupa are unknown, as is also the larval food plant. A female beetle kept by the writer from May till July deposited eggs almost daily, 540 in number, and it was not known how many eggs had been laid prior to that time. The beetle possesses the habit so common to snout-beetles of "playing 'possum" or feigning death when disturbed, dropping off its food plant on the slightest disturbance and remaining for some time before resuming activity. [a]

A beetle parasitized by a fungus (*Sporotrichum globuliferum?*) is illustrated in figure 24.

The imbricated snout-beetle is one of many species of insects which are sporadic as regards injurious attack and troublesome only in seasons following a year which has been favorable to the increase of individuals. The beetles are not restricted to wild plants even in years of scarcity, but are found over the area which they inhabit on cultivated or other useful plants every year. Fortunately the beetle is not only irregular as to destructive occurrences, but is omnivorous as well, subsisting on one plant quite as well as another, thus distributing attack.

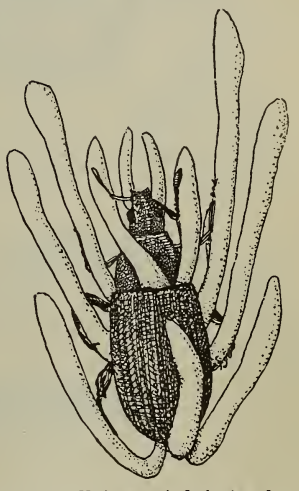

FIG. 24.—*Epicærus imbricatus:* beetle attacked by fungus—three times natural size (author's illustration, Division of Entomology).

Remedies.—This species will yield to the same remedies in use against the Colorado potato beetle. On plants resistant to arsenicals, such as potato, Paris green applied as a spray at the rate of a pound to 100 gallons of water is effective, while on less resistant plants, such as peach and bean, a weaker spray—about 1 pound to 150 gallons of water—or one in which arsenate of lead is the poison, is necessary to avoid scalding the foliage. Arsenicals can also be used dry, mixed with about 10 parts of cheap flour or lime, and applied to the infested plants by means of a hand bellows.

The beetles may be readily dislodged from affected plants by jarring them with a pole or stick upon "curculio catchers" of strong cloth stretched on frames and mounted on wheels or runners. If the cloth is saturated with kerosene, it will kill them; or, as they make little or no effert to escape, they may be easily taken from the "catchers" and killed by burning or by pouring scalding water over them.

Eventually this snout-beetle will probably become rare owing to its being wingless, when it may be replaced by other species having well developed wings.

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[a] A more detailed account is given in Bul. 19, n. s., Div. Ent., pp. 62–67.

CUTWORMS.

These insects are among the most troublesome with which the vegetable grower has to deal, but, although often associated with injury to sugar beet, they as a rule show no preference for this plant. Hence they are of little importance save under exceptional circumstances, when they attack newly planted crops. They are usually present in most gardens and fields, and it is a question of their appearance in numbers and at the time of the year when the plants are just beginning to grow, as to whether they will prove sufficiently destructive to require remedial treatment. They are likely to attack any portion of a beet plant—foliage, flowers, stalks, fruits, or roots—and when they are sufficiently abundant to migrate like army worms they can be quite injurious.

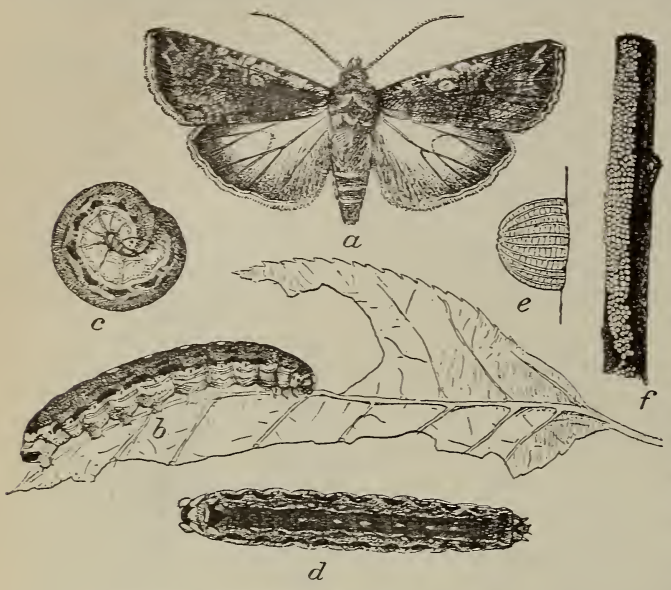

FIG. 25.—*Peridroma margaritosa:* *a*, moth; *b*, normal form of larva, lateral view; *c*, same in curved position; *d*, dark form, dorsal view; *e*, egg from side; *f*, egg mass on twig (after Howard, Division of Entomology).

Although we have two or three score of injurious cutworms, not more than half a dozen of these have been reported to be seriously troublesome to sugar beet. The different species vary considerably as to life and other habits, but in this connection brief mention will be made of only a few of the most important insects of this group.

THE VARIEGATED CUTWORM.

(*Peridroma margaritosa* Haw. [*saucia* Hbn.].)

There is little doubt that this is the most important and widely known of all cutworms. It is cosmopolitan and likely to be found anywhere, and although it favors vegetable crops it is able to eke out an existence on almost any form of vegetation. The progenitor of this cutworm is a rather large grayish-brown moth or "miller," and the full-grown cutworm measures about $1\frac{3}{4}$ inches. It is variable, like the moth, some forms being pale and others darker. The usual ground color is rather dull brown, mottled with gray and smoky black above, the characteristic feature consisting of a row of four to six yellow

medio-dorsal rounded spots. The different stages are shown in figure 25. During the severe outbreak of this species in 1900, already mentioned, practically all forms of vegetables, including sugar and table beets, were attacked, the insect even eating into roots and tubers and devouring the foliage and gnawing the bark of trees.

A detailed account of this species is furnished in Bulletin 29, new series, Division of Entomology.

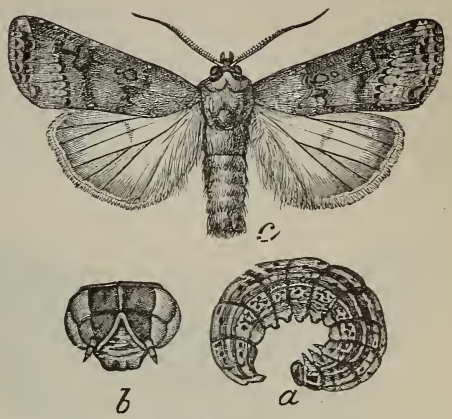

FIG. 26.—*Agrotis ypsilon*, a beet cutworm: *a*, larva; *b*, head of same; *c*, adult—somewhat enlarged (fom Howard, Division of Entomology).

THE GREASY CUTWORM.

(*Agrotis ypsilon* Rott.)

This species is commonly found in fields of beets, and may be selected as typical of its class. In importance as a pest it is perhaps second only to the variegated cutworm. It is of about the same size (fig. 26), and of a dull, dirty brown color, characteristic of most cutworms, with the lower portion paler and greenish, and the entire surface of a greasy appearance, whence the name. It is cosmopolitan, and has a most emphatic and pernicious cutting habit. It is especially troublesome to newly set tomato plants, to potato, corn, lettuce, and tobacco.

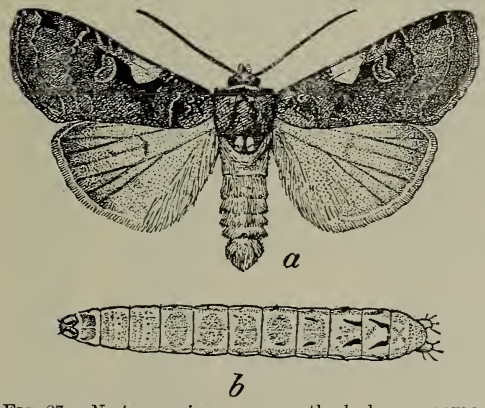

FIG. 27.—*Noctua c-nigrum:* *a*, moth; *b*, larva—somewhat enlarged (author's illustration, Division of Entomology).

THE SPOTTED CUTWORM.

(*Noctua c-nigrum* Linn.)

This is one of our commonest and most destructive species, and is commonly found on beets. It resembles the variegated cutworm in being cosmopolitan, nearly omnivorous, a climbing species, and in migrating in numbers like the army worms. The moth (fig. 27, *a*) has brown forewings, tinged with red or purplish and marked with lighter colors as figured. The cutworm (*b*) is pale brown or gray, sometimes whitish with greenish or olive tints, and has the last segments marked with oblique black lines. It measures, fully extended, about an inch and a half. The principal crops which it has been known to injure include, besides beets, corn, and other cereals, cabbage, cauliflower, turnip, pea, carrot, tomato, celery, rhubarb, currant, gooseberry,

clover, violets and some other ornamental plants. It has been noticed attacking grasses and oats, but does not appear to resort to these plants when more choice food is at hand.

THE WESTERN ARMY CUTWORM.

(*Chorizagrotis agrestis* Grote.)

In 1897 this cutworm, which had hitherto led an unpretentious existence in the Missoula Valley, Montana, developed in great numbers, and a serious outbreak followed. According to the account given by Dr. E. V. Wilcox (Bul. 17, Montana Agl. Exp. Sta., 1898), this visitation resembled that of the common army worm, and the list of observed food plants shows that it can be a very serious vegetable pest, since, besides beets, it attacks cabbage, horse-radish, radish, mustard, turnip, pea, tomato, potato, onion, celery, rhubarb, corn, cereals, grasses, clover and other forage crops, forest and fruit trees, and bush fruits.

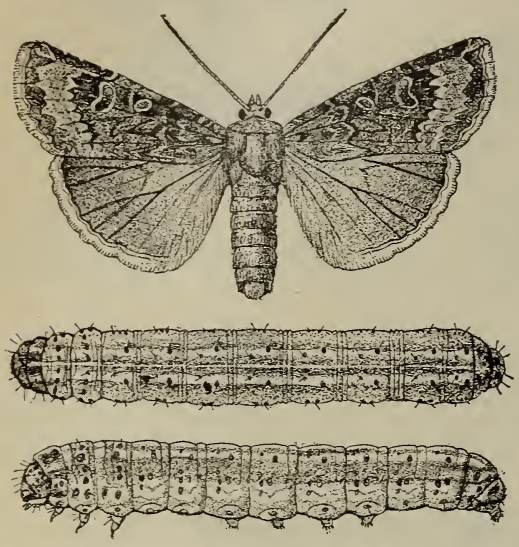

FIG. 28.—*Chorizagrotis agrestis:* moth above; larva, dorsal view, in center; larva, ventral view, below—somewhat enlarged (original, Division of Entomology).

This cutworm (fig. 28) is of the ordinary type, and attains a length of 2 inches when mature. Its body is nearly smooth, only a few short hairs being observable. The color varies from pale green to dark brown. Along the sides there are alternating longitudinal light and dark bands. The moth is brown with gray markings, has a wing expanse of about 1¼ inches, and is quite variable.[a]

The recorded distribution comprises Kansas, Nebraska, Texas, New Mexico, Arizona, Colorado, Montana, and California.

Although the injuries committed in 1897 have not to our knowledge been duplicated, reports have reached us of the occurrence of great numbers of the species in widely separated localities, the moths flying about in such numbers as to become annoying pests in dwellings. Such reports were received from Missouri in 1902, and from Arizona and Colorado in 1903. In Montana a "wild sunflower" (*Balsamorrhiza sagittata*) and avens (*Geum triflorum*) are favorite food plants, but in other localities it seems probable that the natural

[a] This species is so often accompanied by two related forms, more particularly by *Chorizagrotis introferens* Grote, as to give rise to the supposition that all are colorational varieties of the same species, the truth of which will probably be established by rearing from selected females.

food, as with so many other forms of cutworms, consists of wild grasses of little or no value, and when grasses or weeds are replaced by crops these are apt to be attacked, under favoring conditions.

THE COTTON CUTWORM.

(*Prodenia ornithogalli* Guen.)

FIG. 29.—*Prodenia ornithogalli:* dark form, male, above; pale form, female, below—somewhat enlarged (original, Division of Entomology).

This species, although called a cutworm, has little in common with preceding species, being more distinctly marked, more or less diurnal in habit, and in having the cutting trait somewhat feebly developed. In fact, it more nearly resembles the boll worm in its habit of boring into the bolls of cotton and the fruit of tomato. It is a very common species, but as a rule not especially destructive, as it is more solitary than the common cutworms. It has been observed attacking and doing more or less injury to beets, potato, asparagus, cabbage, cucumber, peach, and cottonwood. It is also common on violet, morning-glory, and other ornamental plants, and on weeds, and is frequently found in greenhouses.

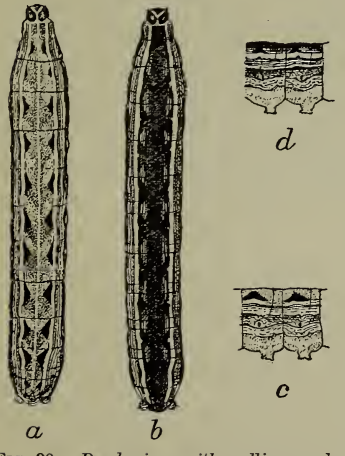

FIG. 30.—*Prodenia ornithogalli: a*, pale form of larva; *b*, dark form of same; *c*, lateral view of abdominal proleg segments of pale form; *d*, same of dark form—all enlarged (original, Division of Entomology).

The moth has a wing expanse of a little less than 1½ inches, and is quite distinct from any which have already been considered, the fore-wings having a more complicated pattern. There is much variation in the colors, which has caused differently colored varieties to be described as species. Two extreme forms are shown in figure 29. That they are mere colorational varieties of one species has been proved by the writer by rearing both from an egg mass deposited by a single female (Bul. 27, new series, Div. Ent., pp. 64–73, 114).

The larva is subject to the same variation as the moth. The ground color is generally olive or greenish brown, finely lined with dark gray and brown, while the upper surface is ornamented with a double row of velvety black or greenish spots, which give it a striking appearance. A pale form of the larva is shown in figure 30 at *a* and a darker form at *b*. It is a singular fact that in the writer's experiments the pale larva produced the dark form of moth and the dark larva the

lighter moth. The distribution of this species is wide, including the territory from Massachusetts to the Gulf, and westward to California, but it occurs in greater numbers southward. In the northern portion of its range it is occasionally killed off by exceedingly cold winter temperatures, as happened in 1899. The larvæ are found abroad from April to November. As with other species which have apparently come northward from the Gulf region, this species is most destructive in the autumn of the year. It is credited with being double-brooded, and possibly three generations are produced in the South. Larvæ have been observed by the writer to complete their development in a month, and the pupal period varies from 12 to 25 days. The winter is evidently passed in the pupal condition, in which respect this species differs from the ordinary cutworm.

THE GREEN BEET LEAF-WORM.

(*Peridroma incivis* Guen.)

In certain years and localities, as in Illinois in 1899 and 1900, this species is more abundant on beet leaves than any other caterpillar. It feeds on both surfaces of a leaf, and has been observed eating purslane, which is doubtless its natural food plant.

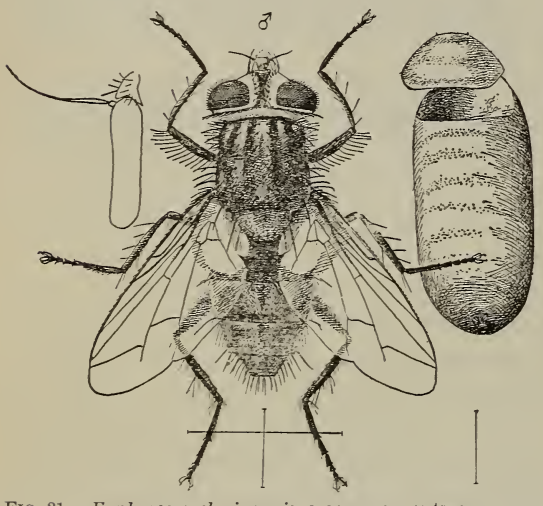

FIG. 31.—*Euphrocera claripennis*, a common cutworm parasite: adult with puparium at right and enlarged antenna at left (from Howard, Division of Entomology).

The larva, also called green cutworm, is green with a white or pinkish stripe on each side of the body. The species is generally distributed, and quite common in Illinois and Kentucky, where it is apparently double-brooded.

NATURAL ENEMIES.

Cutworms are exposed to a great variety of natural enemies, but as a rule these are not efficient checks except when the cutworms appear in great numbers and travel like the army worms. At such times many species of predaceous and parasitic insects and predatory mammals and birds, wild and domestic, destroy them in great numbers. Of the predaceous enemies ground beetles are most abundant, while the parasites include numerous species of ichneumon and tachina flies and a few chalcis flies. A common species of tachina fly is shown in figure 31. Cutworms are also subject to a fungous disease *Empusa aulicæ*. Among birds which are beneficial by feeding upon cutworms are robins, crows, the bluebird, and the bluejay, and among domestic animals are chickens, ducks, turkeys, Guinea fowls, and hogs.

METHODS OF CONTROL.

From what has been said of the utility of domestic fowls and other animals it is obvious that with proper judgment their services would save great losses that it might otherwise be difficult to avert.

Poisoned baits are the standard remedies against cutworms, and to be most effective they should be applied as soon as attack is noticed. They are particularly valuable in cases where the direct application of insecticides to a plant is impossible owing to the danger of poisoning persons or stock when it is used for food. There are two kinds of bait—fresh vegetable and bran mash.

Vegetable bait may be prepared as follows: Spray a patch of clover, pigweed, or some useless succulent plant that grows by the roadside or in fence corners, with Paris green, 1 pound to 150 gallons of water; mow it close to the ground, and place it while fresh in small heaps about the infested plants at intervals of a few feet. The later in the day this can be done the better, as the material keeps fresh longer and the cutworms feed almost exclusively at night. Owing to the wilting of this bait, particularly in dry, sunny weather, it is advisable to cover each heap with a chip, shingle, or bit of bark for its protection against the sun's rays.

Bran mash or bran-arsenic mash is of equal value to a fresh vegetable bait, and, according to some, still more efficacious. Paris green, arsenoid, white arsenic, or in fact any arsenical can be used for poisoning this bait, and in its preparation, on account of the weight of the poison and the fact that it soon sinks to the bottom of the water when stirred, it is best first to mix the bran with water and sugar and then add the poison. The proportions are 2 or 3 ounces of sugar or a similar quantity of glucose or molasses to a gallon of water and a sufficient amount of bran (about a pound per gallon) to make, when stirred, a mixture that will readily run through the fingers.

Before planting a crop it is advisable to employ such bait, and its perfect success is assured by having the ground bare, which practically compels the cutworms to feed upon it.

Bordeaux mixture.—This fungicide has been recently tested against the variegated cutworm upon potato vines and asparagus. It was sprayed on as a remedy for blight, and it was discovered that the plants thus treated were free from attack. The use of this fungicide as a cutworm deterrent is certainly advisable. In any case, it should be used as a diluent for whatever arsenical is used.

Hand methods.—On some plants it is next to impossible to apply any but hand methods with good results. Experiments in Washington State during the season of 1900 demonstrated conclusively that in some cases it required less time to shake or brush cutworms from affected plants than to destroy them by spraying or otherwise.

"*Back firing*," a somewhat old-fashioned practice, is of great use in destroying army worms, cutworms, and other forms of insects when they occur in such numbers as to ruin a crop. It consists in burning a rather wide stretch in advance of the wind at the farthest extremity of the field, and then stamping this out to prevent the fire from reaching other fields beyond. The field is then burned, beginning with the side from which the wind is blowing. This has the effect of destroying the entire field, with all the cutworms and many other insects which it contains, with practically no danger of the fire spreading to fields where it is not desired.

When cutworms assume the habit of traveling in armies they should be treated in the same manner as advised against the army worms.

ARMY WORMS.

In addition to the army cutworm that has been mentioned and the variegated and spotted cutworms, which sometimes exhibit the same migratory tendency, there are three important species of beet-feeding caterpillars, allied to the cutworms, but lacking the true cutworm habit. The most important of these is the beet army worm.

THE BEET ARMY WORM.

(*Caradrina* [*Laphygma*] *exigua* Hbn.)

In the year 1899 this species, which had not previously attracted attention by its ravages, became prominent as an enemy to the sugar beet in Colorado. Subsequent study showed that it had been observed at an earlier date attacking crop and other plants in New Mexico and in California. It is an imported pest, and, although not at the present time of great importance, bids fair, in course of time, to become a serious enemy to the cultivation of sugar beet in America. It has evidently come by way of California and is traveling eastward, a method of migration of which there is precedent in the Colorado potato beetle.

The moth (fig. 32, *a*) is mottled gray, resembling the plain form of the related fall army worm. The fore-wings are broader and paler, and the reniform and other markings are more distinct. The wing expanse is less than an inch and one-half. The larva is rather slender, with a small head, and the body greenish or olivaceous and striped as shown (fig. 32, *b*, *c*, and fig. 33).

When migrating, the beet army worm attacks several forms of vegetation. Sugar beet appears to be the favorite host plant; table beets are also relished, and it feeds quite as well on lambsquarters, pigweed, and saltbush (Atriplex). When numerous, corn, potato, pea, onion, sunflower, and the leaves of apple, mallow, *Nicotiana glauca*, Cleome, plantain, and wild grasses are eaten. In southern California the moths appear in April and until June; caterpillars of the first generation

develop as early as the last week of May and a month later in June. In the cooler climate of Colorado and New Mexico larvæ have been noticed about the middle of June, becoming more abundant in August, when the greatest damage is done. From our somewhat incomplete knowledge of this species it appears that it has a spring and late autumn generation in Colorado and New Mexico, and perhaps a third in southern California, and it is evident that the second generation is generally most destructive.[a]

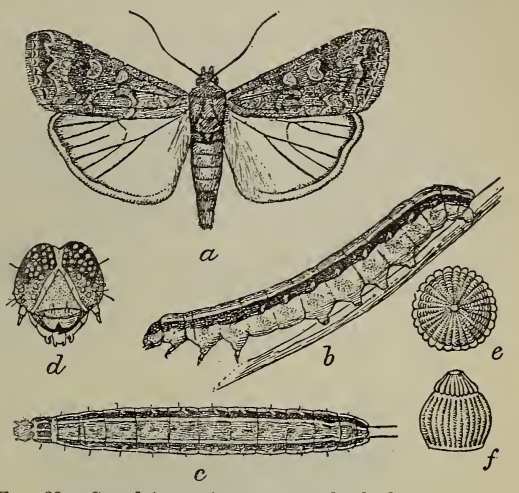

FIG. 32.—*Caradrina exigua: a*, moth; *b*, larva, lateral view; *c*, larva, dorsal view; *d*, head of larva; *e*, egg, viewed from above; *f*, egg, from side—all enlarged (*e*,*f*, after Hofmann; *a*–*d*, after Chittenden, Division of Entomology).

Methods of control.—Several remedies have been employed in Colorado with satisfactory results. These include Paris green and kerosene emulsion, both of which killed the insects and checked their numbers for the following year. Paris green was applied as a spray and dry, mixed with flour. With flour it cost about 80 cents an acre. Two sprayings with the liquid preparation were most effectual. When this species is unduly abundant it should be treated in the same manner as the fall army worm (*Laphygma frugiperda* S. & A.), which is quite often associated with injury to sugar beet. The latter attacks nearly all forms of vegetable and other crops, but as it is discussed fully in Bulletin 29, new series, Division of Entomology, further mention is unnecessary here.

FIG. 33.—*Caradrina exigua:* enlarged section of first proleg segment, dorsal view (original, Division of Entomology).

A third species, the true army worm (*Leucania unipuncta* Haw.), is more strictly an enemy of cereals and grasses, and not, as a rule, of much importance as a beet feeder. Remedies are considered in Circular No. 4, Division of Entomology, and short general accounts of both the true army worm and the fall army worm are furnished in Farmers' Bulletin 132.

WEBWORMS.

Among insects that are nearly always to be found in their natural habitat in fields of beets are two small caterpillars known as webworms. Of these the sugar-beet webworm is a prime beet pest, and the second, known as the garden webworm, is a general feeder, devel-

[a] In a more complete consideration of this species, Bul. 33, new series, Div. Ent., pp. 37–46, references to economic articles by C. P. Gillette and others are furnished.

oping on weeds related to beets and invading cornfields and vegetable gardens when the supply of wild food plants and weeds is scant. Still a third species, the imported cabbage webworm, occasionally occurs on beets, but, as its name indicates, it is a cabbage pest, properly speaking, and does not resort to other plants when Cruciferæ are available.

THE SUGAR-BEET WEBWORM.

(*Loxostege sticticalis* Linn.)[a]

Although primarily a sugar-beet insect, this species, like many others that have been treated, is a periodical pest, and, as it is an introduction from abroad and widening its range, there is likelihood that it will in time assume greater economic importance. It is cousin to the native garden webworm, but the moth is larger, darker colored, and the markings are somewhat more pronounced. With the

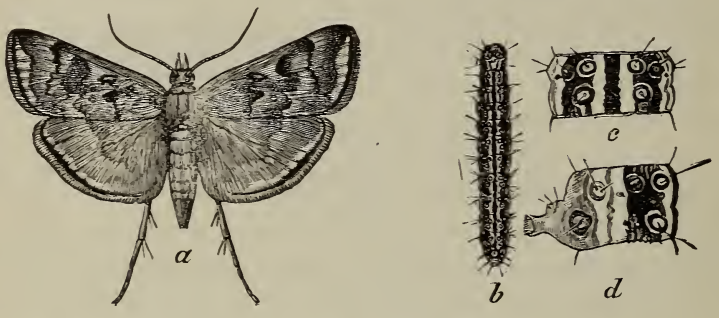

FIG. 34.—*Loxostege sticticalis: a*, moth, twice natural size; *b*, larva, less enlarged; *c*, upper surface of first proleg segment of larva; *d*, side view of same; *c*, *d*, more enlarged (reengraved after Insect Life, Division of Entomology).

wings fully expanded it measures nearly an inch and is of a purplish brown color, with darker and paler bands, as shown in figure 34, *a*.

The pale-yellow eggs are laid singly or in rows of two to five or more, overlapping like scales. The young webworms are whitish, with polished black head and piliferous spots. Mature caterpillars (*b*) are darker than the garden webworm, with a preponderance in longitudinal markings.

It is an inhabitant of western and central Europe and northern Asia, and has evidently, like the beet army worm, been introduced from the Orient on the Pacific coast, and is now slowly but steadily pushing its way eastward. In 1869 it came under observation in Utah, and by 1873 had found its way to Missouri. It occurs southward to Kansas and as far north and east as Michigan, but the major portion of reported injuries have occurred in Kansas and Nebraska.

Practically all that is known of the biology of this webworm is from

[a] Riley & Howard, Insect Life, Vol. V, pp. 320–322; Vol. VI, pp. 369–373; Chittenden, Bul. 33, new series, pp. 46–49.

data accumulated by the Department of Agriculture. The life history has not been followed throughout, but two generations have been differentiated, and possibly a third is produced in the most southern region which the insect inhabits, the moths from which issue in autumn. Where observed in Nebraska there was a short-lived July generation, requiring only two weeks between the maturity of the caterpillars and the appearance of the moths, which coupled and deposited eggs for another generation. The caterpillars of the July brood transform to pupæ almost immediately after entering the ground, but the last generation remains as larvæ for some time before assuming the chrysalis stage. A wild food plant, pigweed or careless weed (Amaranthus), has been observed, and it has been noticed also that injury to fields of sugar beet are most observable where the ground had been allowed to run to this wild plant. In Europe it lives on another pigweed (Artemisia). A parasitic enemy of this species is illustrated in figure 35.

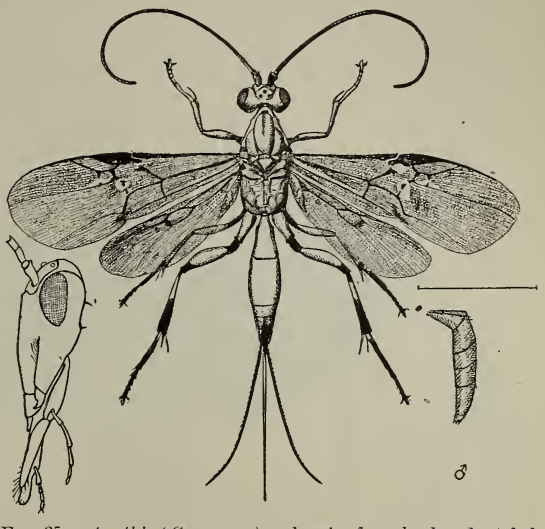

FIG. 35.—*Agathis* (*Cremnops*) *vulgaris:* female, head at left; abdomen of male, side view, at right—enlarged (redrawn after Insect Life, Division of Entomology).

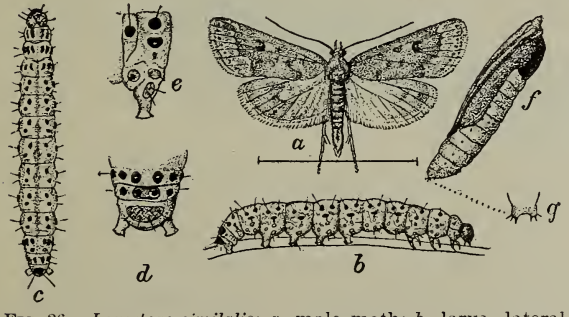

FIG. 36.—*Loxostege similalis: a*, male moth; *b*, larva, lateral view; *c*, larva, dorsal view; *d*, anal segment; *e*, abdominal segment, lateral view; *f*, pupa; *g*, cremaster—*a*, *b*, *c*, *f*, somewhat enlarged; *d*, *e*, *g*, more enlarged (reengraved after Riley, except *c*, original, Division of Entomology).

THE GARDEN WEBWORM.

(*Loxostege similalis* Gn.)

The garden webworm has the same natural food plant (Amaranthus) as the sugar-beet species, but is native to America, and although widely distributed is somewhat restricted as regards important injuries to the South and Middle West, particularly in States between the Mississippi Valley and the Rocky Mountain region. In 1885 it was the cause of serious trouble over a large area, including five States and Indian Territory.[a] It is a general feeder, and attacks most vegetables, cereals, grasses and other forage crops, as also tobacco

[a] Rept. Comm. Agr. for 1885 (1886), pp. 265–270.

and sugar-cane, but its injuries are most pronounced on corn and cotton. The moth (fig. 36, *a*) is variable from yellow to buff, and there is variation in the degree of markings of the fore-wings. The expanse is about three-fourths of an inch. The larva (*b*, *c*) is also variable, the ground colors running through pale and greenish yellow to dark yellow. It seems probable that, as two generations have been observed in the Middle States and three in the South, the life history of this species is not materially different from that of the beet webworm. Eggs are deposited on lower surfaces of leaves, and the caterpillar, soon after hatching, draws together the edges of a leaf by means of its web, or fastens together two contiguous leaves, forming a shelter, from which it crawls forth to feed. A parasite of this species is shown in figure 37.

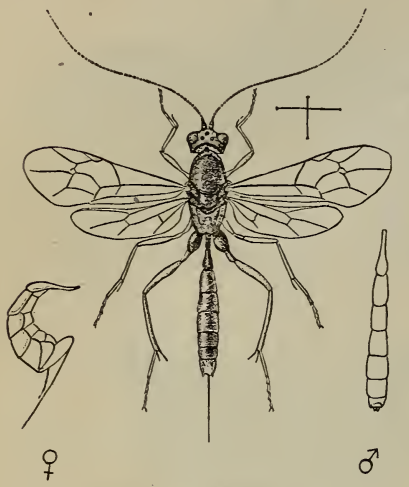

FIG. 37.—*Limneria eurycreontis:* adult female; ♀, abdomen of female, lateral view; ♂, abdomen of male, dorsal view (after Insect Life, Division of Entomology).

Remedies.—Paris green applied as a spray has been used with perfect satisfaction against both of these webworms, the fact that they are more or less surrounded by webs and leaf tissues offering little or no barrier to the effects of the poison. In addition, clean cultural methods, including late plowing in the fall followed by deep plowing in spring, and the burning of all waste material and weeds, are of service in controlling these pests. Early planting is also useful as a safeguard for some crops.

MISCELLANEOUS CATERPILLARS.

In addition to the caterpillars which have been mentioned—cutworms, army worms, and webworms—a number of other forms of different classes and with varying habits are so frequently found in beet fields as to deserve consideration. The first two that will be mentioned are naked caterpillars; the last two are hairy caterpillars, or woolly bears, as they are familiarly termed.

THE WHITE-LINED MORNING SPHINX.

(*Deilephila lineata* Fab.)

An illustration and short account of this species, known also as the purslane sphinx, is presented, because it is frequently found in beet fields and evinces an apparent preference for beet among cultivated plants. From its very large size it might be judged a pest of importance. On the contrary, it feeds naturally on purslane, seeming to

injure beets only when the former plant is exhausted or unavailable. Occasionally it occurs in some numbers, as has happened in several localities in the past three years, and then may attack various other useful plants, among which turnip, watermelon, buckwheat, grape, and the leaves of apple have been recorded. During 1900 Mr. Edward C. Post reported injury to sugar beets at Dundee, Mich., and Mr. T. Lytle, Manzanola, Colo., reported damage to tomatoes and to apple and prune trees.

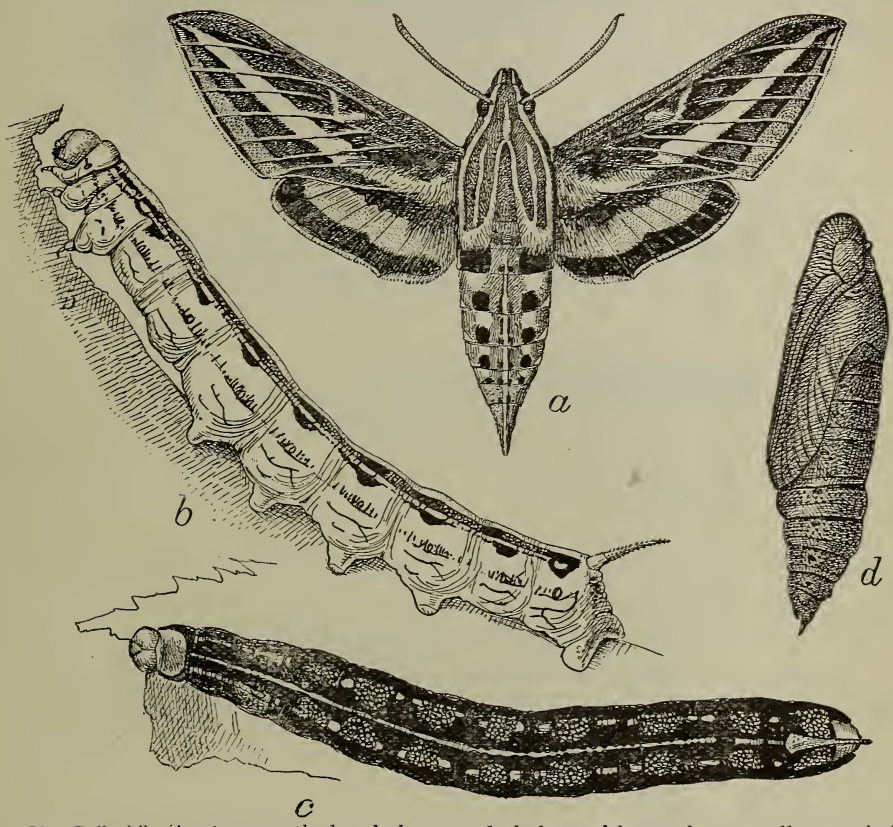

FIG. 38.—*Deilephila lineata: a*, moth; *b*, pale larva; *c*, dark form of larva; *d*, pupa—all natural size (original, Division of Entomology).

The resemblance of the adult (fig. 38, *a*) to a humming bird is marked particularly when the insect is in flight. It will be noted that there are two forms of the caterpillar, a light one (*b*) and a dark one (*c*). The insect belongs to the same group as the more familiar tomato and tobacco worms, and its life habits are somewhat similar.

Remedies.—On account of the large size of this insect it is not difficult to control it by picking the young caterpillars from the plants and destroying them. They also succumb to the arsenicals.

THE ZEBRA CATERPILLAR.

(*Mamestra picta* Harr.)

The zebra caterpillar is a conspicuous garden pest, particularly attached to vegetables, showing some preference for beets and spinach,

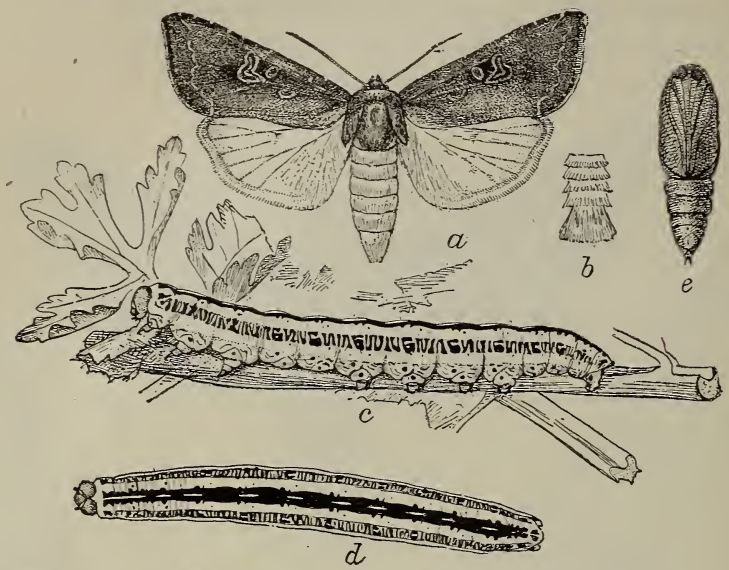

FIG. 39.—*Mamestra picta: a*, female moth; *b*, abdominal segments of male moth; *c*, pale form of larva, lateral view; *d*, larva, dorsal view; *e*, pupa—all somewhat enlarged (original, Division of Entomology).

cabbage, celery, peas, and asparagus, and feeding at times on nearly all forms of vegetation, including cereals, weeds, and the foliage of trees. As previously mentioned, it bears the distinction of being the first insect reported to affect beets in this country. The moth (fig. 39, *a*) resembles in general contour the progenitors of cutworms belonging to the same group of insects. It has a wing expanse of about an inch and a half; the fore-wings and thorax are brown, shaded with darker purplish brown, and the hind-wings are white, tipped with pale brown at the margins. The larva or caterpillar (fig. 39, *c*, *d*) is somewhat variable, but the head is red and the ground color yellow, more or less strongly marked with black, the stripes on the sides suggesting the name of zebra caterpillar. The larva when first hatched from the egg is dull gray and looks quite unlike the mature form. Two views of the newly hatched larva are presented in figure 40, *a*, *b*, while the third stage is shown at *c*.

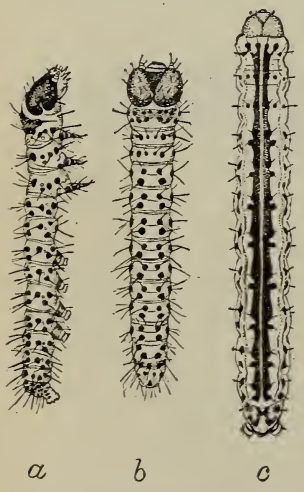

FIG. 40.—*Mamestra picta: a*, *b*, newly hatched larva; *c*, larva of third stage—much enlarged (original, Division of Entomology).

This species is quite abundant in the North, becoming most trouble-

some in the second generation, which usually appears in September. In addition to the plants that have been mentioned as furnishing food for the zebra caterpillar are cauliflower, turnip, beans, carrot, potato, corn, currant, cranberry, willow, roses, and others. The winter is passed in the pupal condition, and the moths appear in May and June. The first eggs hatch in a moderate temperature in six days, and the larval period is about five weeks. The pupal period is very long, lasting, as observed by the writer, sixty-seven days, making in all a period of one hundred and ten days from the time the eggs were laid until the moths appeared, late in August. This species can endure a considerable amount of cold, but is very susceptible to parasitic attack, and to a less extent to fungous diseases.

Methods of control.—The caterpillars when first hatched are gregarious, hence easily discovered at this time and destroyed by hand or by poisons. They yield readily to sprays of arsenicals, but these are not necessary in ordinary cases of attack.

THE SALT-MARSH CATERPILLAR.

(*Leucarctia acræa* Dru.)

Several forms of hairy caterpillars, such as the yellow bear (*Spilosoma virginica*), of similar appearance and habits, are commonly found on sugar beet. One of these, known as the salt-marsh caterpillar

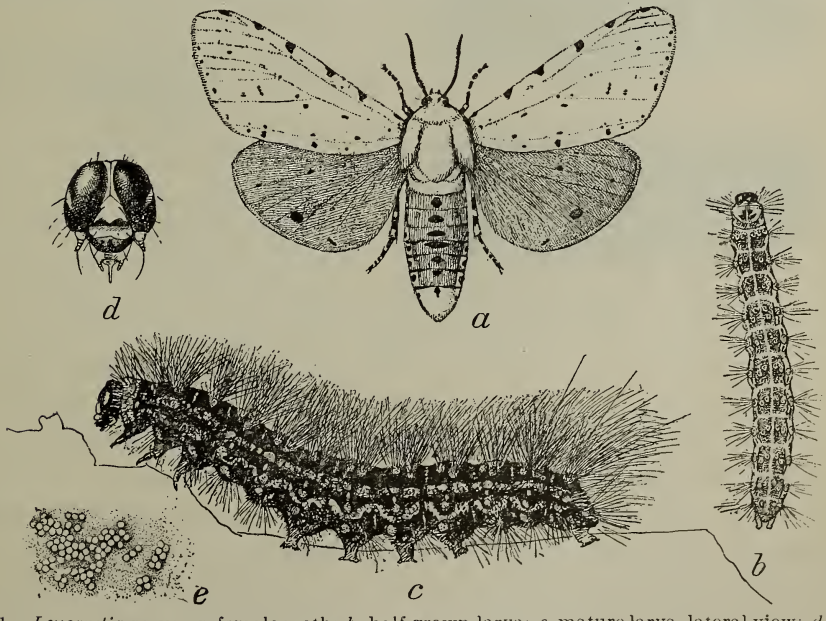

FIG. 41.—*Leucarctia acræa: a*, female moth; *b*, half-grown larva; *c*, mature larva, lateral view; *d*, head of same, front view; *e*, egg mass—all slightly enlarged except *d*, more enlarged (original, Division of Entomology).

(*Leucarctia acræa* Dru.), from its ravages early in the past century upon forage crops grown in the salt marshes of New England, is occasionally troublesome in beet and corn fields and in gardens.

This caterpillar differs from the common yellow bear in having a darker body, and the sides are distinctly ornamented with yellow markings. The two species are of about the same length, and the hairs present a similar variation in color. A young larva is illustrated at figure 41, *b*, a mature one at *c*. The moths also closely resemble each other, but the fore-wings of the present species are strongly marked with black, and the abdomen, with exception of the first and last segments, is bright ocher above, with black markings. In the female the hind-wings are white, like the fore-wings, and similarly marked with black, but in the male they are ocher with two black dots (fig. 41, *a*). The life economy of these species is very similar; they form the same sorts of cocoons and transform in any convenient place where shelter can be obtained. In New England the salt-marsh caterpillar is credited with having a single generation, but a little farther south, in the Middle States, two generations have been recognized.

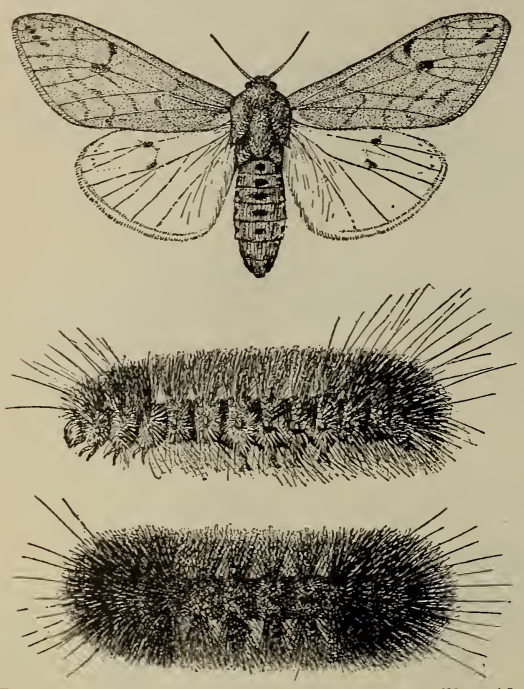

FIG. 42.—*Isia isabella:* male moth above; caterpillar, side view, in middle; dorsal view at bottom—somewhat enlarged (original, Division of Entomology).

THE HEDGEHOG CATERPILLAR.

(*Isia* [*Pyrrharctia*] *isabella* S. & A.)

Another conspicuous caterpillar known to attack beets is shown in the accompanying illustration (fig. 42). It is recorded also as affecting peas and corn, but appears to prefer plantain and other weeds, such as dandelion and burdock. The general color of this caterpillar is bright cinnamon red and usually each end is black. The long hairs with which the body is covered are so evenly distributed as to give it the appearance of being shorn or cropped. The name of hedgehog caterpillar is derived from the habit of this insect of rolling up when disturbed and of passing the winter under the bark of trees or in some similar location rolled up like a hedgehog. The life history of this insect is very similar to that of the preceding. The moth (fig. 42) is dull orange, with the fore-wings marked with dusky stripes, both the fore and hind-wings being spotted with black, the latter a little paler than the others.

Remedies.—As a rule neither this insect nor the salt-marsh caterpillar occurs in troublesome numbers; hence remedies are not often necessary. It can be controlled by ordinary methods of spraying and hand picking.

GRASSHOPPERS, CRICKETS, AND RELATED INSECTS.

Of great economic importance in the West, and in some seasons in other regions, are numerous species of locusts, popularly termed grasshoppers. Several forms of related insects, such as katydids and crickets, are also injurious, but all of these insects are general feeders, and as a rule destructive to sugar beets and other vegetable crops only in seasons which have been particularly favorable to their multiplication, and their operations are mainly confined to fields adjacent to grass lands. The numbers of these insects mount into the hundreds, but the really important species might be reduced to between twenty and thirty. Fourteen are listed as sugar-beet pests.

For present purposes it will be necessary to mention specifically only a few of the most abundant of the grasshoppers. Like most other forms of the order Orthoptera, they are mostly large insects, with mouth parts formed for biting, and with incomplete metamorphoses, the young more or less closely resembling the adults, save for the lack of wings. Their name is sufficient indication of their habits: They live normally on grasses for the most part, and their thighs are large, fitting them for long leaps. Everyone knows them so well that further description is unnecessary. Some species are capable of extended flight for hundreds of miles, with occasional intermissions daily for food. In their migrations they go in swarms, and sometimes darken the face of the sun, or at night of the moon.

Grasshoppers may be classified, as regards their habits, as nonmigratory and migratory. The former breed and pass their entire lives in or near the place where the eggs were laid. The migratory species breed in enormous numbers, and when they become too abundant for the limited food supply of a region, they develop the migrating habit and travel in swarms. These insects are particularly abundant and troublesome in arid and semidesert regions, and as their numbers are subject to great variation according to climatic and other conditions, the visitation of a locust swarm may be expected at any time during the warmer months of the year. In dry regions locusts are the most dreaded of insect pests. Because of their voracity and the rapidity of their attack, they lay waste entire townships, counties, and even large portions of States.

THE RED-LEGGED LOCUST.

(*Melanoplus femur-rubrum* De G.).

This is our commonest North American grasshopper, being found practically everywhere. It is one of the smaller species (fig. 43), and where it is not held in subjection by numerous natural enemies of various kinds it may become a decided nuisance in cultivated lands. It was destructive to sugar beet in Illinois in 1899. It seldom exhibits the migratory tendency, but sometimes gathers in swarms and moves in concert, not, however, rising to great heights, but drifting with the wind as do the true migratory species.

FIG. 43.—*Melanoplus femur-rubrum*—natural size (after Riley).

THE ROCKY MOUNTAIN LOCUST.

(*Melanoplus spretus* Thomas).

This is the most destructive of all native grasshoppers, and has been the cause of greater losses to agriculture in the past thirty years or more than perhaps all of the other known species of grasshoppers combined. Its range of injuriousness is not limited to the Rocky Mountain region, but it is more abundant there than elsewhere. It is illustrated in figures 44 and 45.

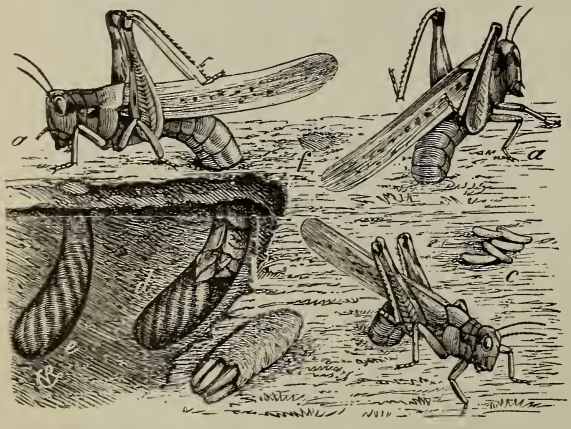

FIG. 44.—*Melanoplus spretus: a, a, a,* female in different positions, ovipositing; *b,* egg-pod extracted from ground, with the end broken open; *c,* a few eggs lying loose on the ground; *d, e,* show the earth partially removed, to illustrate an egg-mass already in place and one being placed; *f,* shows where such a mass has been covered up (after Riley).

Those who were interested in farming in the 70's in Kansas, Nebraska, and some neighboring States have cause to remember the depredations of the Rocky Mountain locust. During 1874–1877 it was directly responsible for the loss of $100,000,000, in addition to an indirect loss by the stoppage of business and other enterprises which might have aggregated as much more. It was for an investigation of this species that the

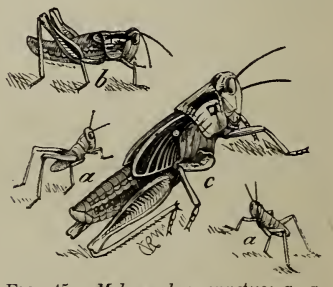

FIG. 45.—*Melanoplus spretus: a, a,* newly hatched nymph; *b,* full-grown nymph; *c,* pupa, natural size (after Riley).

United States Entomological Commission was formed, which published from 1877 to 1879 two voluminous reports on it alone. A shorter account of this and some of the other more important grasshoppers discussed in the Commission Reports is furnished in Bulletin No. 25 (o. s.), Division of Entomology.

THE DIFFERENTIAL LOCUST.

(*Melanoplus differentialis* Thomas.)

In Kansas and Nebraska and elsewhere in the Middle West the farmer is much bothered at times by the large yellow locust, shown in figure 46. It can usually be found along roadsides and on the edges of groves, preferring rank vegetation where such abounds. When it becomes unusually numerous it is quite destructive to vegetable crops and to cereals; in fact, it is rated by some as next in importance to the two species which have been considered. Two forms of this insect make their home in the Middle West—a yellow form, which is the commonest, and a black one. They do not appear to differ otherwise than in color.

FIG. 46.—*Melanoplus differentialis*, natural size (after Riley).

THE TWO-STRIPED LOCUST.

(*Melanoplus bivittatus* Say.)

The name two-striped locust and the accompanying illustration (fig. 47) together with the statement that the ground color of this species is brown, striped with yellow, is sufficient for its determination. It is somewhat variable, however. Like others of its kind it develops where vegetation is rank, in weed patches and in low ground, and after exhausting the vegetation in such localities it enters gardens and cornfields and does much injury to crops. It occurs from the Atlantic to the Pacific, and from the Gulf States to far North.

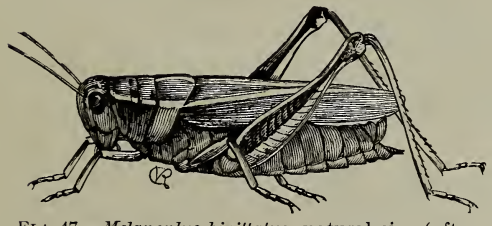

FIG. 47.—*Melanoplus bivittatus*, natural size (after Riley).

METHODS OF CONTROL.

Grasshoppers are generally kept within normal numbers by numerous natural agencies, among which are nearly all large forms of insectivorous birds and mammals, batrachians and reptiles, and fungous diseases. They also have large numbers of predaceous and parasitic

insect enemies, which kill them off in ordinary seasons. With changes of atmospheric conditions, however, the insect and fungous enemies are frequently destroyed, and then the grasshoppers increase in abundance. In such cases they can be destroyed by several artificial methods. The remedies that have proved most efficient are: (1) plowing under the eggs before these have had time to hatch, and

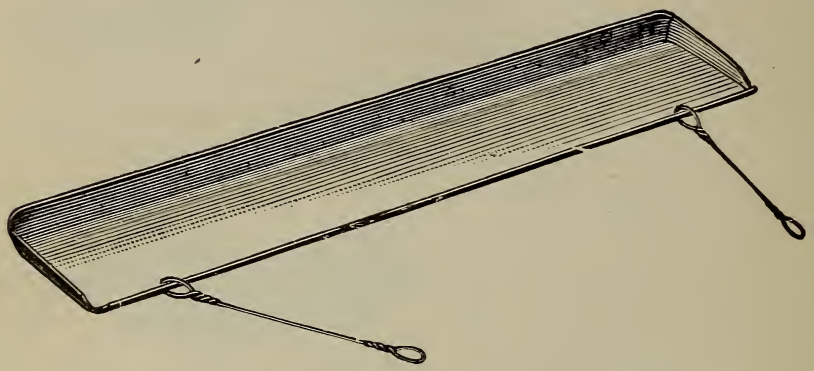

FIG. 48.—A simple coal-tar pan to be drawn by hand (after Riley).

(2) capturing the unfledged locusts, as well as many of those which have become winged, by means of hopperdozers or kerosene pans.

Hopperdozers are necessary implements of warfare against most grasshoppers. They are shallow sheet-iron pans, made of any size most convenient, or canvas frames, mounted on runners to be drawn over the ground either by a horse or by hand, preferably against the wind, in such a manner that the grasshoppers will leap into them and be killed by coming into contact with the tar or oil which is poured into them for the purpose. Two forms of hopperdozers are shown in figures 48 and 49.

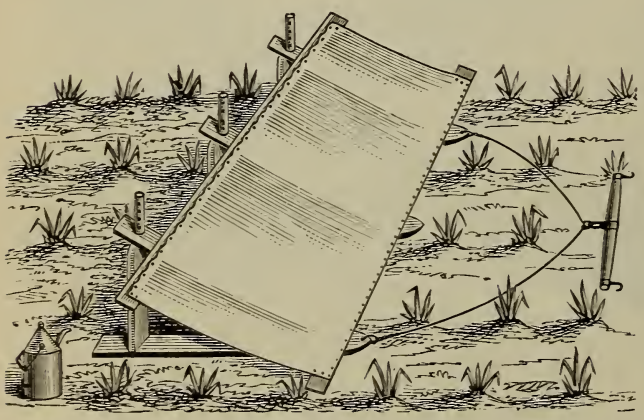

FIG. 49.—A canvas hopperdozer to be drawn by horse (after Riley).

Bran-arsenic mixture is another remedy of great value in the prevention of injury to our cultivated crops. The directions for preparing this mash have been given under remedies for cutworms (page 185).

Fungous diseases as a remedy.—During the years 1901–2 the subject of the possible control of grasshoppers by means of contagious diseases was taken up by the Division of Entomology, and a report by Dr.

Howard of progress in experimental work was published in the Yearbook of the Department for 1901 (pp. 459–470). Unfortunately the spread of these diseases is so contingent upon certain weather conditions that while uninfected grasshoppers may be inoculated under the most favorable circumstances, we can not always obtain or predict atmospheric conditions which will operate with the disease in destroying the grasshoppers. The conclusion is therefore reached that, owing to the inability of man to control the conditions necessary to the spreading of the disease, it is far better to employ the bran-arsenic mash, hopperdozers, fall plowing, and other remedies which have been specified where possible in preference to the fungus; in other words, we can not depend absolutely on the fungus, although in some cases it is eminently beneficial, more especially in climates which are unusually moist and in which the conditions desired are ordinarily present. The principal diseases in question are caused by *Mucor ramosus*, *Empusa grylli*, and an undetermined species of the genus Sporotrichum.

Poisoned horse droppings.—During recent years Mr. Norman Criddle has used a mixture with great success against locusts in Manitoba. It consists of 1 part of Paris green mixed thoroughly in 60 parts of fresh horse droppings, 2 pounds of salt to half a barrel of mixture being added after being dissolved in water. This is placed in a half barrel and drawn on a cart to the edge of the infested field or one likely to be invaded. The mixture is then scattered broadcast along the edge of the crop, or wherever needed, by means of a trowel or wooden paddle. The locusts are attracted to it and are killed in large numbers by eating the poison.[a] Although this mixture is "sure death," it sometimes requires from two to five days for it to kill the locusts.

Rye as a trap crop.—Manitoba farmers also deal successfully with locusts by sowing a strip of rye around the edge of a field of wheat. The former grain grows more rapidly and it requires a long time for the insects to eat sufficiently of it to destroy it. The rye is poisoned with a spray of Paris green. Beet fields might be protected in the same manner.

Burning over and plowing.—In some cases it has been possible to ascertain the particular breeding places of grasshoppers, some species depositing their eggs in pasture lands and among foothills at the bases of mountains in the far West in regions in which the tar weed grows. Here the egg cases can be destroyed by burning over the ground late in the fall after all of the eggs are deposited, or by plowing them in to a depth of 6 or 8 inches before they hatch in the spring.

In case, for any reason, it is not feasible to employ any of these last-mentioned remedies, and the place of egg deposit is ascertained, a watch should be kept for the young grasshoppers and they should be

[a] Fletcher, Rept. Ent. and Bot. Experimental Farms, Canada, for 1902, 1903, p. 187.

destroyed as soon as possible after hatching by means of the bran-arsenic mash.

Turkeys.—Prof. Lawrence Bruner, of Nebraska, states that turkeys are useful in freeing orchards and vineyards of grasshoppers and they may be employed in other fields for the same purpose. In one case a flock of 766 turkeys was kept at work in the destruction of grasshoppers. The turkeys have to be watched, however, as they sometimes vary their diet with vegetables.

Cooperation is of the greatest value in the treatment of grasshoppers, particularly in regions where they reach their greatest development; and the thoroughness with which work is done in one year will show in the greatly reduced numbers with which the farmers will have to deal the next season.

Many of the remedies that have been advised as remedies for grasshoppers in general are applicable to the migratory forms, but these frequently occur in such immense swarms that it is practically impossible to check them until the crops are destroyed. It is of the highest importance, therefore, that remedies be employed at the very first onset, and that these measures be generally observed over considerable territory, as the insects fly rapidly from one field to another.

LEAF-MINERS.

Three forms of maggots, the young of small two-winged flies, more or less resembling the common house fly, mine the leaves of beets and spinach, causing variable blotches on the outer cuticle, which is left entire until ruptured by the escape of the maggot when it matures and deserts its old home for transformation in the earth below. The abandoned mines dry, shrivel, and become torn by subsequent growth of the plant.

THE BEET OR SPINACH LEAF-MINER.

(*Pegomya vicina* Lintn.).[a]

The beet or spinach leaf-miner is the best known of these insects, and at the present time the only one that need be considered. It is practically confined to beets, spinach, and like plants, such as lambs-quarters, and is to be reckoned among prominent beet pests, as it is apparently increasing in destructiveness.

The parent fly is shown at figure 50, *a*, *b* representing the head of the male, and *c* that of the female. The ground color is gray with the front of the head silver white. The body, including the legs, is rather

[a] Lintner, 1st Annual Rept. Insects N. Y. for 1881 (1882), pp. 203–211; Howard, Insect Life, Vol. VII, pp. 379–381; Sirrine, 14th Rept. N. Y. Agricultural Experiment Station for 1895 (1896), pp. 625–633; Pettit, Bul. 175, Mich. State Agr. College Exp. ta., 1899, pp. 356–357.

sparsely covered with long stiff black hairs. When in action the body is carried usually in a somewhat curved position, but when extended measures nearly a quarter of an inch. The maggot (*f*) is white, and so nearly transparent that the contents of the abdomen can be seen through the posterior portion.

In many cases infestation can be traced directly to the insects having bred in lambs-quarters and similar weeds, which if not destroyed by ordinary methods of cultivation mature and die during October. The flies, by close observation, may be seen in flight just above the ground or hovering about their different food plants. The eggs are placed on the lower surface of the leaves and arranged in masses of from two to five. When the young hatch they bury themselves

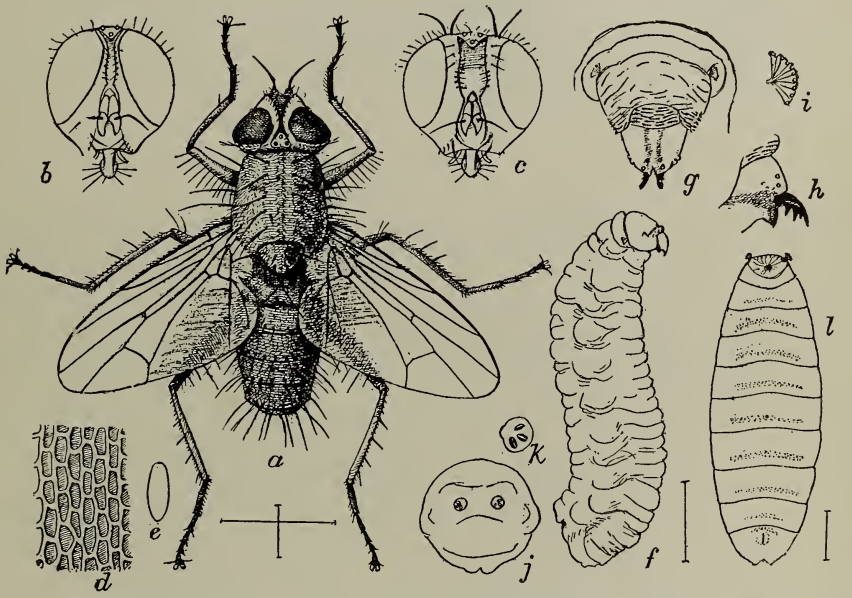

FIG. 50.—*Pegomya vicina: a*, fly; *b*, head of male fly; *c*, head of female; *d*, surface of egg, highly magnified; *e*, egg; *f*, maggot; *g*, head of same; *h*, cephalic hooks of maggot; *i*, prothoracic spiracles; *j*, anal segment; *k*, anal spiracles; *l*, puparium—all enlarged (after Howard, Division of Entomology).

within the leaf tissue, constructing a thread-like mine which they afterwards extend in a curve or semicircle.

Transformation to pupæ takes place in most cases in loose soil, which the maggots enter only to a short distance or under fallen leaves. Occasionally maggots transform within a leaf if the latter happens to rest on the ground.

Injury appears to be most frequent in late fall, but may be due to earlier generations in midsummer. Dr. Howard states that eggs hatch in from three to four days, and the larval stage is passed in seven or eight days, the puparium or resting stage requiring from ten to twenty days. These periods will vary according to the state of the atmosphere. An instance of damage to spinach in Pennsylvania was reported in May, 1903.

Methods of control.—When this leaf-miner occurs in kitchen gardens it is most easily controlled by gathering and destroying the leaves as soon as found infested, and neighboring plants which serve it for food should be treated in the same manner. In large fields of sugar beet much injury might be averted by proceeding in the same manner at the outset of attack.

Insecticides have been suggested, but the habit of the maggot of feeding within the leaf at once indicates their uselessness. Kerosene emulsion has been tried without effect. Mr. Sirrine has observed that many gardeners and farmers on Long Island, where this insect is a spinach pest of importance, have practiced late fall and early spring plowing, and are still troubled with it. But it is probable that clean culture is not also practiced, hence the insects have an opportunity to breed in weeds and return to cultivated plants. As the insect appears to prefer spinach to beets, it is possible that the former might be used as a trap crop in sugar-beet fields.

PLANT-BUGS.

The sugar beet furnishes sustenance for hordes of sucking insects, such as plant-bugs, plant-lice, leaf-hoppers, root-lice, and numerous related forms, but many of these insects live normally on wild plants, weeds, and grasses, on which their younger stages are passed, and prefer most other vegetable crops, when readily obtainable, to beets. Among the more common forms of these insects which obtain nourishment by suction are several species of true bugs of the family Capsidæ, generally termed plant-bugs, although some forms are also known as leaf-bugs, chinch bugs, and by similar names indicative of their habits or appearance. The commonest and most injurious of these insects are two forms of false chinch bugs and the tarnished plant-bug and garden flea-hopper.

THE TARNISHED PLANT-BUG.

(*Lygus pratensis* Linn.)

As this is the commonest of all bugs, and, according to general verdict, one of the most troublesome, it may serve as an example of this class. It is at home practically everywhere in North America, from Canada to Mexico, and attacks most plants whether cultivated or wild. It occurs in fields of sugar beet throughout the warm season, and frequently does damage to garden crops, both vegetable and fruit, and to trees grown in nurseries.

The mature plant-bug is of the appearance shown in figure 51 at the left. The general color is a pale, obscure, grayish brown, marked with black and yellow, the thorax also with red. The pattern is variable, but more or less as illustrated. The legs are still paler brown or yellow-

ish, ringed with darker brown. The length is about one-fifth or three-sixteenths of an inch.

This plant-bug has been stated to pass through four stages of growth from the time it hatches from the egg until it reaches the adult condition, but there is little doubt that there are five stages, to agree with other species of plant-bugs which have been traced through their metamorphoses. In the first stage the insect measures only one-twentieth of an inch, and is yellowish or yellowish green in color. The known stages are shown in figures 51 and 52.

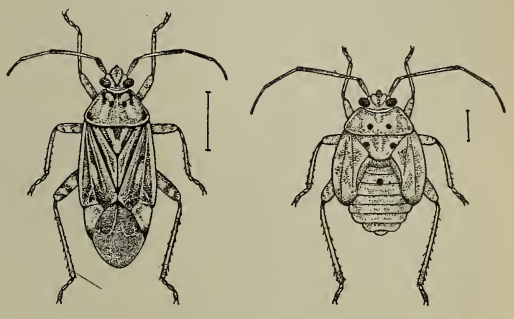

FIG. 51.—*Lygus pratensis:* adult bug at left; last stage of nymph at right—nearly four times natural size (original, Division of Entomology).

Were it not for the fact that this plant-bug feeds upon such a variety of crops as well as weeds, thus diminishing the damage, it would be much more injurious than it really is. It has been asserted, and with probable truth, that the puncture of the bugs is poisonous to plant life.

The bugs are extremely active, and quick of flight as well as on foot, and when disturbed in the least have the habit, in common with many other plant-bugs, of dodging to opposite sides of the plant, where they remain out of sight.

The tarnished plant-bug, as previously stated, can be found afield throughout the season, appearing in early spring and disappearing only when cold weather approaches. Hibernation is usually in the adult stage, but the nymphs or immature forms are sometimes seen under circumstances that would lead to the belief that the species also winters over in this stage. The insects pass the winter under any convenient shelter, particularly in rubbish left in fields and in fence corners, and under leaves, boards, and stones. After copulation in early spring the females deposit their eggs singly and directly on their host plants, oviposition continuing for two weeks or longer.

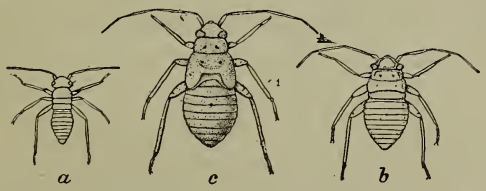

FIG. 52.—*Lygus pratensis: a,* newly hatched nymph; *b,* nymph of a later stage; *c,* fourth stage—three or four times natural size (after Forbes, Division of Entomology).

Remedies.—The great activity of the tarnished plant-bug, coupled with its habit of feeding on so great a variety of plants, passing from one to another with no apparent choice, renders it more difficult of control than if it were concentrated. It can not be kept in bounds by any single remedy, at least when it occurs in great numbers. In the application of insecticides, or other remedial measures, it is necessary

to include other food plants or most forms of vegetation in order to keep the insects away from the crop which is being injured.

Kerosene emulsion is one of the best remedies, but must be applied thoroughly and at frequent intervals.

Pyrethrum must be applied in the same manner, but as it is one of the most expensive of insecticides its use would hardly be profitable on beets, although valuable on some other plants subject to injury, for example, on berries, where it is impossible to apply poisons that would be harmful to man.

If insecticides are employed they are best applied early in the morning, before the insects have become thoroughly active and while the dew is on the plants, as this facilitates the spreading of most applications which are used.

Hand methods, although scarcely applicable to large fields, are of the greatest value over small areas, and a hand net of stout cloth is useful for sweeping plants and surrounding grasses and weedy vegetation in which the insect is sure to be found. A day's experience will be sufficient to teach anyone that more insects can be captured in this manner than in any other.

Clean culture, although mentioned last, is the first necessity, and if fields subject to injury by this plant-bug are kept free from weeds of all kinds and the rubbish is cleaned away as soon as the crop is harvested, losses will be greatly lessened. After a crop is off "burning over" or "back firing" should be practiced in the same manner as already described in connection with army worms and cutworms.

THE FALSE CHINCH BUG.

(*Nysius angustatus* Uhl.)

This plant-bug is a beet feeder of long standing, and like many other species which have been mentioned, shows a tendency toward being omnivorous, although cruciferous plants, such as cabbage and turnip, appear to be the favorite food. It does more or less injury to potato, lettuce, grapevine, strawberry, and even grass and the foliage of apple trees. Its English cognomen is derived from the fact that since very early times it has been sent by correspondents to official entomologists under the impression that it was the true chinch bug, to which, indeed, it is related.

It is grayish brown and of the appearance shown at figure 53, *c*, measuring about one-eighth of an inch. In the same figure, at *a*, a leaf of potato is illustrated, which shows minute circular specks which are rusty in color where the beak of the bug has been inserted. This recalls the method of attack of certain flea-beetles which have already been described. When occurring in large numbers the false chinch bugs crowd together on plants after the manner of chinch bugs on corn,

and harlequin bugs on cabbage, and as they feed by suction they soon exhaust a plant by depriving it of its vital juices, causing it in time to wilt and perish. The distribution of the species extends from New Hampshire to the Gulf, and westward to the Pacific States. It is subject to the same atmospheric influences as the true chinch bug, damp, rainy weather being unfavorable to its development.

Remedies.—The best manner of holding this bug in control consists in clean culture, keeping down all purslane, a favorite host plant, the careful cleaning up of crop remnants and other trash before winter, and the collection of the bugs when they occur in numbers in pans or pails filled with water and a thin scum of kerosene. The free use of kerosene emulsion and pyrethrum is also of value, the latter, though expensive, being efficient in small fields.

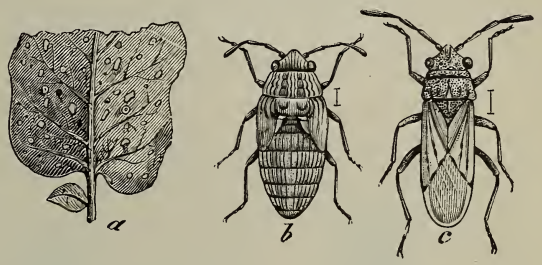

FIG. 53.—*Nysius angustatus: a*, part of small leaf of potato, showing punctures of the bug; *b*, last stage of nymph; *c*, adult—*a*, natural size; *b*, *c*, much enlarged (after Riley, Division of Entomology).

THE MINUTE FALSE CHINCH BUG.

(*Nysius minutus* Uhl.)

According to recent reports emanating from several sources in Colorado, this insect is of growing importance as a beet pest. It appears to be more particularly destructive to beets grown for seed, the injury being accomplished by the bugs sapping the green seed, which in consequence dries up and fails to mature properly.

It differs but slightly from the previously mentioned species, being a little smaller, measuring only about a sixteenth of an inch in length. Its distribution and its food habits appear to be practically the same, in fact additional study is necessary to determine whether the two forms are actually distinct species.

Remedies.—It has been ascertained by beet growers that the flooding of infested fields causes the insects to leave, and the growing of mustard as a trap crop has given excellent results, precautions being taken that the mustard be not allowed to run to seed, as it is likely to become a pest itself. Other remedies advised for the common false chinch bug just considered are also applicable.

THE GARDEN FLEA-HOPPER.

(*Halticus uhleri* Giard.)

In recent years this minute black bug has been the occasion of considerable injury in various parts of the country. In 1890 it did damage to beans in Kansas, and in 1896 like injury was inflicted on red clover and other plants in Ohio. It is commonly seen in beet fields,

but evinces a partiality for leguminous plants, including cowpea and pea, and has also been destructive to smilax in greenhouses and to potato, morning-glory, and chrysanthemum. In 1897 it was somewhat troublesome on edible legumes in Maryland. Among other plants which it attacks are egg-plant, pumpkin, cabbage, and numerous weeds. It occurs most abundantly on the under side of leaves, which it punctures so as to cause the death of the tissue in small, irregular, somewhat characteristic white patches.

This species is shown highly magnified in fig. 54 in the three forms of its adult stage. In its brachypterous or short-winged form it greatly resembles the common black cucumber flea-beetle, alike in appearance, in the nature of its work, and in its saltatory power. It is evidently native and well distributed from Canada and New England southward to Florida and westward to Utah. This shows a range

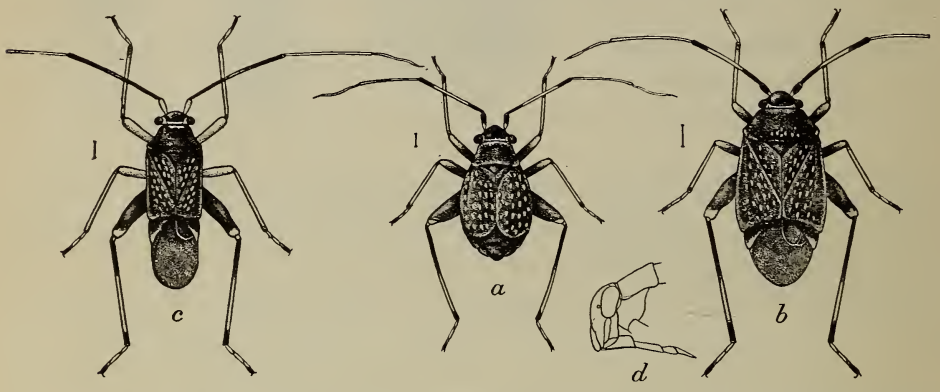

FIG. 54.—*Halticus uhleri:* *a*, brachypterous female; *b*, full-winged female; *c*, male; *d*, head of male in outline—*a*, *b*, *c*, much enlarged; *d*, more enlarged (author's illustration, Division of Entomology).

from the Boreal life zone to the Gulf strip of the Lower Austral. According to the observations of Mr. F. M. Webster, this species may hibernate in the adult stage, although probably it usually passes the winter in the egg.

Remedies.—The best remedy is kerosene emulsion applied thoroughly as an underspray.

Many of the instances of injury that have been reported have been largely due to the planting of susceptible crops in the immediate vicinity of clover, which is evidently the preferred host plant. When the clover is cut the flea-hoppers migrate to other crops, and when sufficiently numerous cause damage. It is obvious that with a little care in cropping, such as the avoidance of growing crops subject to injury in the immediate vicinity of clover, much injury would be averted.

LEAF-HOPPERS.

Numerous species of leaf-hoppers, insects which obtain their food by suction in the same manner as plant-lice, are nearly always to be found on sugar beet and similar vegetables. None of these, however, appears to be restricted to vegetables for food, but usually develop on grasses, although occasionally also on other plants. As a rule, in their earlier stages they exhibit a decided limitation to the food plant on which they began breeding; but as they near the more mature stages they assume the habit of feeding more indiscriminately. Considerable divergence is exhibited in regard to life histories; but since these insects are, as a rule, not particularly destructive to beets, further discussion of this general problem may be omitted.

THE CURRANT LEAF-HOPPER.

(*Empoasca mali* Le B.)

This leaf-hopper is described by Messrs. Forbes and Hart as "probably our worst all-round leaf-hopper pest, so excessively abundant that notwithstanding its varied diet it is able to make a serious attack on quite a number of the cultivated plants on its list." It has been found in extreme abundance on sugar beet everywhere in Illinois, both as nymph and adult, showing its ability to breed on this plant. It also attacks beans, cowpea, potato, celery, and corn, and various fruits, as well as shade and forest trees. It is a tiny insect, pale green in all stages, and is apt to be confused with related species. The row of six (sometimes eight) white dots along the anterior margin of the prothorax distinguishes it from others.

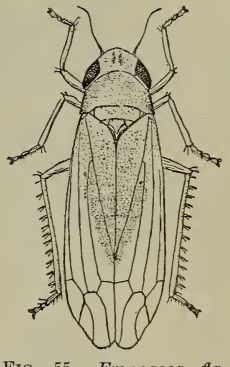

FIG. 55.—*Empoasca flavescens*—highly magnified (original, Division of Entomology).

THE FLAVESCENT LEAF-HOPPER.

(*Empoasca flavescens* Fav.)

Very similar to the preceding in appearance, size, habits, and distribution is the above-mentioned species (fig. 55). It is sometimes even more abundant. It is paler, nearly white, and has only three spots on the margin of the thorax.

REMEDIES.

As a result of studies of the life economy of leaf-hoppers, it has been ascertained that simply cutting the grass and perhaps some other plants affected, and leaving it in the field, will prevent eggs from hatching; the drying of the stems results in the crushing and distortion of the eggs, owing to the shrinkage of the plant tissues and the curling of the edges of the sheaths.

PLANT-LICE.

Several forms of plant-lice affect the leaves of sugar beet, but as far as at present known do not inflict extensive injury. Among the plant-lice, however, are some few forms which have the habit of feeding on the roots, being known as root-lice, and these are of the greatest importance when atmospheric conditions conduce to their development or the plants are first injured through other causes.

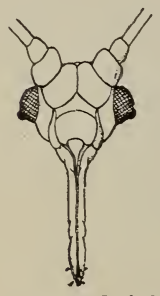

FIG. 56.—Head of plant-louse, showing sucking beak—much enlarged (original, Division of Entomology).

THE MELON PLANT-LOUSE.

(*Aphis gossypii* Glov.)

The melon plant-louse or, as it is more commonly known, the melon louse, is perhaps the commonest species found on beets, and is the best known as well as most destructive of all insects of this class. Fortunately for the beet grower it does not favor this crop, and is usually found only in moderate numbers on beets when other plants are available. The writer has seen a considerable number of this species on beet leaves working in their usual manner by pumping up the juices through their beaks (fig. 56), but although the plants were carefully watched the operations of the plant-lice did not seem to hinder the growth of the plants in any degree. Nevertheless, this louse is capable of serious damage, more especially in the event of exhaustion of favorite host plants, like melons and other cucurbits, which would drive it to beets if these were most available. The principal forms of this insect are illustrated in figure 57.

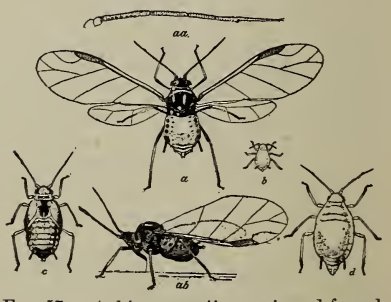

FIG. 57.—*Aphis gossypii: a*, winged female; *aa*, enlarged antenna of same; *ab*, dark female, side view; *b*, young nymph or larva; *c*, last stage of nymph; *d*, wingless female—all greatly enlarged (original, Division of Entomology).

The melon louse is probably of American origin and perhaps tropical, since it prefers plants of a tropical nature, has a very wide distribution in North and South America and the West Indies, and has been observed in Australia. It is therefore apt to be present in most fields of sugar beet, but its occurrence there can usually be traced to other plants on which it develops more freely, some of which have already been mentioned. Among others of the favorite host plants are cotton, okra, purslane, strawberry, and orange and other citrus trees. Attack begins in early spring and may last until winter, according to season, climate, and other circumstances.

Natural enemies.—As an illustration of an insect pest held in abey-

ance and limited to innoxious numbers by natural enemies, no better example could be cited than is afforded by this plant-louse. Its natural enemies include several species of ladybirds or "ladybugs," syrphus flies, aphis lions, the larvæ of lace-wing flies, numerous species of minute hymenopterous parasites, and a parasitic fungus. The insect enemies are most effective in destroying the plant-lice in dry and warm weather. In a cool, damp atmosphere, which is apt to be encountered early in the season when plants are first set out, the insect enemies are as a rule less active, and at such times injury by plant-lice is likely to be most severe.

The species shown in figure 58, known as the convergent ladybird (*Hippodamia convergens*), is one of the most beneficial insects, as it is

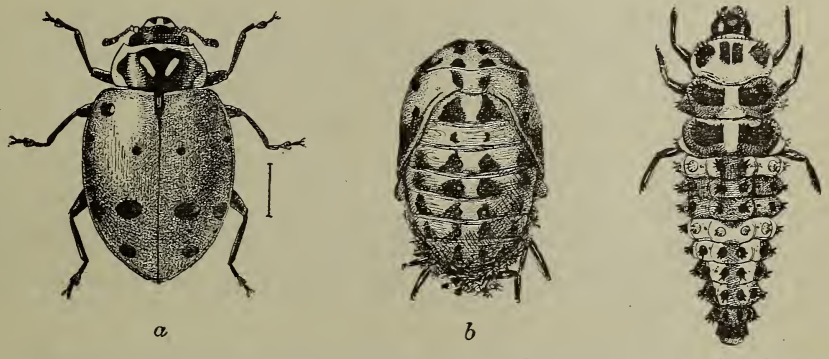

FIG. 58.—*Hippodamia convergens: a*, adult; *b*, pupa; *c*, larva—all much enlarged (original, Division of Entomology).

a most active destroyer of plant-lice which feed on vegetables. It is common on sugar beets, and it is interesting to note that on one occasion it was reported as feeding on the leaves of that plant in Oregon (Bul. 26, o. s., Div. Ent., p. 11).

METHODS OF CONTROL.

The melon louse, although a difficult insect to treat when it occurs on cucurbits and some other plants, can be more readily controlled on beets. In fact, all of the leaf-infesting plant-lice can be destroyed on beets by means of sprays and other washes and by some of the ordinary general methods of farm practice.

Kerosene emulsion.—The standard remedy for plant-lice is kerosene-soap emulsion, made by combining 2 gallons of kerosene, half a pound of whale-oil or fish-oil soap or 1 quart of soft soap, with 1 gallon of water.

In preparing this emulsion the soap is first dissolved in boiling water and then poured while boiling hot, but away from the fire, into the kerosene. The mixture is then churned somewhat violently for about five minutes by means of a force pump and direct discharge

nozzle throwing a strong stream by pumping the liquid back upon itself. When properly combined the mixture will have become of the consistency of thick cream. It is then placed in moderately tight receptacles, and will keep almost indefinitely until required for spraying, when it is to be diluted. For plant-lice this staple emulsion is usually diluted with from 10 to 15 or 20 parts of water.

Its habit of feeding on the lower surfaces of leaves renders the melon louse more difficult to reach by means of a spray than insects which live on the upper surfaces. In the application of an emulsion or other wash, therefore, it is necessary that the hose be fitted with an upturned nozzle in order to secure the under spraying of the leaves, which is the principal resort of plant-lice and many other sucking insects.

It is of the utmost importance that the sprays or other remedies be applied on the first appearance of the insect in order to check it before it succeeds in obtaining a good start and to prevent its further development.

Spraying with water.—A strong stream of water from a hose directed on plants, so as to hit the insects, is of much value in dislodging them from the plants, to which they do not usually succeed in returning, and where this can be readily done more elaborate remedies are unnecessary.

Pyrethrum administered with a powder bellows to the lower sides of leaves is also valuable and particularly effective on young plants. It is, however, expensive, and can not be profitably used in large fields.

Clean culture and fall plowing should be followed as the most effective measure of prevention of attack by plant-lice as well as other insects, and this includes the keeping down of weeds after the main crop has been gathered until the next crop is planted, this treatment serving to rid the fields of many pests, particularly those which do not fly readily, by depriving them of food.

Fumigation methods.—In very recent years two methods of fumigation have been rather extensively practiced as a means of destroying the melon louse and related insects on valuable plants. It is doubtful, however, if either of these remedies would be necessary on beets except in regions where injury is more extensive than has thus far been reported.

If careful watch is kept for the first appearance of this plant louse it can be more thoroughly eradicated by means of fumigation than by any other method. The method of application of bisulphid of carbon consists in covering the affected plants on the first appearance of the pest with a tub or similar receptacle, and evaporating the chemical beneath this at the rate of a dram to 1 cubic foot or less of space

inclosed. A tablespoonful serves for ordinary tubs. This treatment does not injure the plant, and if the tub fits tightly to the ground the vapor of the bisulphid is retained and the lice will all be killed. This remedy is much used by growers of melons and cucumbers who watch their vines carefully, removing and destroying affected plants and fumigating those which can be saved.

THE BEET APHIS.

(*Pemphigus betæ* Doane.)

This insect is a root-louse and comparatively new as a pest. Attention was first drawn to it in 1896, and for three or four years afterwards it did considerable injury to sugar beet in Washington.[a] We do not know its full life history nor its distribution, but it occurs also in Oregon and probably in California. In Oregon a thousand tons or more of beets were ruined in a year in a single valley. This insect is one of many which may be seemingly harmless up to a certain point, but, with a changed environment, become of more importance economically.

The smaller rootlets of beets are first attacked and, when the aphis occurs in large numbers, they are soon destroyed. The loss of these so weakens the plant that it is not able to withstand further attack, and, as a result, the leaves wither and the beet shrivels and becomes spongy. Wild yarrow (*Achillea lanulosa*) appears to be a normal host plant, and when its roots are examined in localities where the insect abounds, they will frequently be found covered with the white woolly excretion of the insect, while the louse itself is feeding on the smaller rootlets. This species also lives on knotweed or door-mat weed (*Polygonum aviculare*), on grasses, and some other plants. It is likely to increase its range, but this may be a matter of slow accomplishment, unless it is introduced from one locality to another on beets in shipment.

METHODS OF CONTROL.

Owing to the large acreage which is planted in sugar beet in many portions of our country, it does not seem probable that we can treat satisfactorily an insect like this root-louse, which feeds underground, by means of insecticides. Kerosene emulsion and bisulphid of carbon will no doubt kill it, but the expense would be excessive were either used on a large scale. Nor can we hope entirely to eradicate the pest when it has taken up quarters in our fields by means of cultural methods. Additional observations on its life history and experiments look-

[a] Cordes: Sugar Beet Gazette for November, 1899; Doane: Bul. 42, Wash. State Agr. Expt. Sta., 1900, pp. 3–11.

ing to better methods for its destruction are necessary. It has been reported of the beet-root louse, which will receive next treatment, that in spite of heavy flooding and plowing in winter, the exposure of infested soil to frost, the number of the insects the following year was much larger. Nevertheless, in some localities these farming methods might be employed with better success against one or the other of these two insects. The best that can be recommended at the present time is to avoid planting beets on land where other food plants of this root-louse grow and where it is known to be established, and to practice judicious rotation of crops. It is advisable also to search for these food plants and destroy such as are of no value. Where the insects are found here and there in fields it might be found profitable to kill them by means of kerosene emulsion applied to the roots so as to soak down into the ground, making use of this remedy before rainfall or following it where possible with a copious flooding of water.

Possibly in time some of our insect friends, such as certain forms of ladybirds, syrphus flies, or parasitic insects, may come to the rescue and solve the problem. Ants are without doubt associated with this as with other root-lice and serve as distributors of infestation by carrying wingless lice from plant to plant. If ants occur in the same fields and it can be seen that they foster the root-lice, their nests should be sought out and destroyed.

THE BEET ROOT-LOUSE.

(*Tychea brevicornis* Hart.)

The above name is suggested for a subterranean plant-louse described in 1894 (18th Rept. Ins. Ill. for 1891–92, p. 97), and found about corn roots in Illinois. Considerable complaint has been made of injury to sugar beets in Colorado in 1901 and 1902 by what is now considered this species. It was described as sapping great numbers of beet roots, diminishing the stand to a large extent. The winged insect was noticed as early as April 1st. A correspondent of the division of entomology, Mr. W. K. Winterhalter, stated that many fields in the Arkansas Valley were infested, and expressed the opinion that if the pest should continue to spread, the sugar-beet industry might be seriously damaged. It is quite apparent that this insect is increasing as a pest, and that it will be difficult to control, as it has already shown its capability of development on a variety of plants, including wild grasses and cereals, among which are corn and sorghum, and such weeds as pigweed, lambs-quarters, "salt-grass," and purslane.

Remedies.—The remedies to employ are the same as for the preceding species of root-louse.

WHITE GRUBS AND MAY BEETLES.

Several species of white grubs and wireworms, the young of May or June beetles and of "snap bugs" or "skipjacks," respectively, attack the roots of beets, but none of them appear especially to favor this form of food and we have yet to learn of very serious damage by any of them. Both of these forms of insects follow the planting of beets in grass lands, and if some other plant be used as a first crop before the planting of beets in virgin prairie or in sod land the chances of infestation will be reduced to a minimum.

It is recorded that about 15 per cent of a field of beets was once destroyed in Nebraska by white grubs, and the roots of beets in central Illinois have also been injured, causing the plants to wilt. Only two forms of white grubs have been identified with attack on beets, but there are undoubtedly many more which affect this crop.

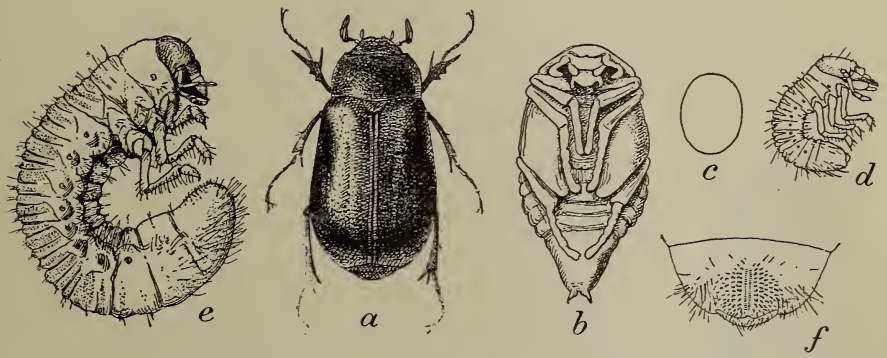

FIG. 59.—*Lachnosterna arcuata: a*, beetle; *b*, pupa; *c*, egg; *d*, newly hatched larva; *e*, mature larva; *f*, anal segment of same from below—*a*, *b*, *e*, enlarged one-fourth; *c*, *d*, *f*, more enlarged (author's illustration, Division of Entomology).

One of the commonest forms of May beetles is illustrated, with its white grub, in figure 59, which also shows the egg and pupa. A more complete account of this species is furnished in Bulletin 19, new series, of the Division of Entomology (pp. 74–80).

THE RUGOSE MAY BEETLE.

(*Lachnosterna rugosa* Mels.)

This species was found by Forbes and Hart in the year 1900 injuring the roots of beets in central Illinois and causing the plants to wilt. The beetle is of about the same size and color as the arcuate May beetle previously mentioned. It is a little paler, however, and the elytra are more distinctly lined with ridges, while the thorax is more strongly and much more closely covered with punctures. Its distribution extends from Massachusetts to Louisiana and Texas, and westward to Colorado and Montana.

METHODS OF CONTROL.

Living as white grubs do, underground, and often at a very considerable depth below the surface, it is obvious that it is a matter of extreme difficulty to reach them with insecticides. Gas lime has been suggested for this purpose, and good results have followed the experimental use of bisulphid of carbon and kerosene emulsion against allied species.

Kerosene emulsion is an effective remedy where small areas, such as beds of strawberries grown for home consumption, are affected. It should be diluted about ten times, and poured over the surface of the ground about the infested plants. It is well to make the application just before rainfall, that it may be washed deep into the soil, so as to come into direct contact with the larvæ. If rain does not fall within a day or two after its application a copious watering should follow.

It is to be regretted that both the bisulphid of carbon and kerosene emulsion remedies are too expensive for use on a large scale, but white grubs may be effectually killed off on lawns and in small fields and gardens by the use of the latter.

Fall plowing.—Everything considered, the most useful remedy is found in fall plowing. The land should be thoroughly broken, so as to leave it loose, and the grubs and their parents, the May and June beetles as well, exposed as much as possible to the elements during the winter. This is particularly valuable in cold weather, as the white grubs are not able to withstand exposure to a severe frost. A cross plowing is sometimes advisable where there is severe infestation. This will insure the ground being often disturbed, and if it is kept clean of weeds and other vegetation the grubs will be held in nearly complete control though not exterminated. Summer fallowing of infested land is said to be useful.

Rotation of crops is also valuable in connection with fall plowing. In case infested meadow land is desired for the planting of beets, corn, strawberries, or other crop subject to severe injuries by white grubs, an application of fertilizer, such as nitrate of soda or kainit, put on as a heavy top dressing after the ground is prepared and before planting, has proved of benefit in some cases.

Domestic animals.—Chickens and turkeys, as well as several species of insectivorous birds, are efficient destroyers of white grubs, and much good may be accomplished by encouraging domestic fowls to follow in the furrows to pick up the grubs as they are turned up by the plow. Hogs, as is well known, are also exceedingly fond of white grubs, and if allowed the run of localities where these are abundant, after the crop is made, they will root up the ground and devour great numbers of them. These and many wild animals also kill and devour the beetles when they have opportunity.

Care in the selection of manure.—As manures are frequently infested by white grubs, some of which are at times troublesome, it is well to exclude such forms as experience has shown to contain an excess of these creatures, as, for example, horse manure. The white grubs can be identified readily by disintegrating the material, and chickens and other fowls can be utilized in destroying them before the manure is spread on the fields.

Attracting to lights.—May beetles are strongly attracted to lights, and especially to electric-light globes. They can be captured to some extent by means of stationary lanterns and pans of water, on which is floating a thin scum of kerosene, placed below the lanterns. The traps should be stationed at intervals about an infested field, particularly around its borders.[a]

THE CARROT BEETLE.

(*Ligyrus gibbosus* DeG.)

This beetle was reported during the year 1890 by Professor Bruner as having been quite destructive to the sugar beet in the western portion of Nebraska. They worked for the most part on old ground where irrigation was practiced, and their operations extended on the roots from the surface of the ground to 3 or 4 inches below; in some instances 7 inches.[b] This insect is better known as a carrot pest, and is, in fact, one of the worst known enemies of carrot, parsnip, and some related plants. Injury is due to both larvæ and beetles. Young corn is often cut just above the roots, and the root crops mentioned are punctured with little holes, rendering them unfit for market. Tubers of potato and sweet potato are also subject to attack, as are the roots of celery. Other plants affected include the roots and tubers of sunflower and dahlias as well as cotton.

FIG. 60.—*Ligyrus gibbosus:* adult—enlarged (original, Division of Entomology).

The beetle closely resembles the May beetle, but it will be noticed by reference to figure 60 that the surface of the wing-covers is strongly sculptured and coarsely punctate. The beetle measures about a half to five-eighths of an inch in length, with considerably shorter legs than in the true May beetles. The dorsal surface is similarly colored,

[a] NOTE.—It is often desirable to protect choice trees against the ravages of the beetles. For this purpose nothing is better than mosquito netting. Beetles may be beaten from the trees into inverted umbrellas or similar receptacles, and can be readily captured and killed, as they make little effort to escape after being dislodged. Spraying with arsenicals is of no practical use, as the beetles continue feeding until the poison takes effect, and the next day the dead are replaced by other individuals.

[b] For particulars see Bul. 23, o. s., Div. Ent., p. 17.

but the lower surface is reddish brown and the legs are clothed with reddish-yellow hairs.[a]

Remedies.—Unfortunately the carrot beetle works under ground, like common white grubs, and for that reason is as difficult to control. Injury is largely confined to the beetles, although the larvæ do some injury. If we could ascertain the principal breeding places, this might furnish a solution of the problem. The grubs may be treated as described in preceding paragraphs. In a case of reported injury to the roots of sweet corn in Minnesota in 1902 the presence of the carrot beetles was traced to their having developed in horse manure on the infested grounds;[b] hence avoiding the use of this as a fertilizer or the destruction of the white grubs in the manure is recommended. Crop rotation is one of the best remedies, and it is probable that trap lights might yield good results, as these insects are more attracted to bright lights than are ordinary May beetles, although it is not known to what extent the beetles might be lured from the fields after they have begun to feed.

WIREWORMS.

The sugar beet, as has been said, is so nearly exempt from injury by wireworms that this plant, as also spinach, might be profitably used as an alternate in the cultivation of corn, various other cereals, and vegetable crops, such as potatoes, which are frequently very badly infested by these insects. Occasionally wireworms of several species have been found eating into the smaller roots of beets and burrowing into the tap roots and crowns, causing the plants attacked to shrivel and die. Messrs. Forbes and Hart have indicated two species of wireworms as having been concerned in such injury, *Melanotus cribulosus* and *Drasterius elegans*, both of which have been observed about beet roots which had been more or less injured and eaten away.

The term wireworm is applied to numerous forms of elongate wire-like creatures, the larvæ of snapping beetles or "snap-bugs," of the family Elateridæ. Many species are injurious to cultivated crops and are often very troublesome in cornfields. A large proportion of the wireworms are shining yellow in color, while many of the adults, like the species figured, are brown and covered with close brown or yellowish pubescence.

The life history of injurious subterranean species is in some respects similar to that of white grubs, the beetles being among the earliest spring arrivals, occurring in April and May, and flying rapidly in the heat of the day.

The eggs are generally deposited in moist places grown up with grassy vegetation, weeds, or corn, and the larvæ upon hatching feed,

[a] A more complete account is given on pp. 32–37 of Bul. 33, n. s., Div. Ent.

[b] Washburn, 7th Rept. Ent. Minn. for 1902, pp. 47–49.

like the white grubs, upon the roots, developing slowly and requiring about the same period for the perfection of the life cycle—about two or three years. Like the white grubs, also, the wireworms transform to pupæ in autumn, and the change to the beetle form takes place before winter, the beetles usually remaining in a quiescent state until their emergence the following spring.

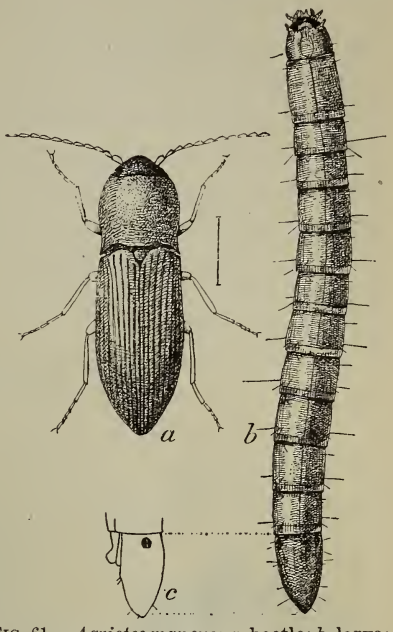

FIG. 61.—*Agriotes mancus: a*, beetle; *b*, larva; *c*, anal segment of larva in profile—about four times natural size (author's illustration, Division of Entomology).

Two common and injurious species are chosen as examples of this class, although it must be remembered that they have not been determined as beet feeders. The first is known as the wheat wireworm (*Agriotes mancus* Say), and is shown four times natural size in figure 61. The other is called *Monocrepidius vespertinus* and is introduced here because known in its three principal stages (fig 62).

Remedies.—Owing to their extremely hardy character, indicated by the hard, firm texture which has given them the name of wireworms, as well as to their subterranean nature, these insects are even more difficult to treat satisfactorily than the white grubs.

Of direct applications, poisons are of little value, but salt in large quantity has been used by some persons with success for many years, and has been reported to be one of the most effective applications that can be made. Strong brine, however, must be used with caution, as it sometimes destroys certain forms of plant life. Different forms of salty fertilizers are also said to be of value, both as stimulants to the affected plants and as insecticides. Among these are kainit and nitrate of soda.

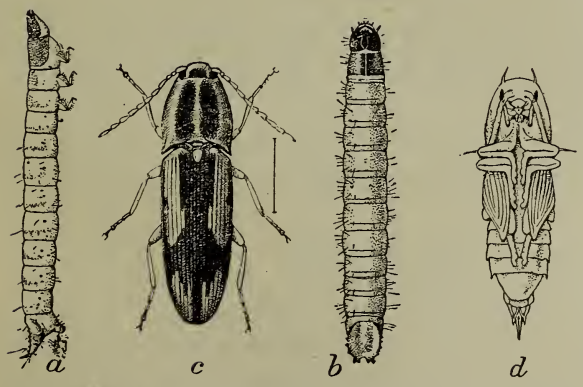

FIG. 62.—*Monocrepidius vespertinus: a*, larva, side view; *b*, same, dorsal view; *c*, beetle; *d*, pupa—about three and one-half times natural size (author's illustration, Division of Entomology).

Clean cultivation and poisoned baits are also recommended, the same as for white grubs. In fact, where remedial measures are in use against either cutworms or white grubs, they apply also to wireworms, but are less effective.

One of the best forms of bait to be used consists of slices of potatoes or other vegetables poisoned in the same manner as advised in the consideration of cutworms.

MISCELLANEOUS ROOT-INFESTING INSECTS.

In addition to white grubs, wireworms, and root-lice, which have been treated as invading the underground portion of beets, a few other species are found at the roots. Prominent among such are the seed-corn maggot and the clover-root mealy-bug. A number of complaints have been made of injury by insects which lead to the belief that the seed-corn maggot is frequently found on beets, although instances which could be positively traced to this species are comparatively few.

THE CLOVER-ROOT MEALY-BUG.

(*Dactylopius trifolii* Forbes.)[a]

This species, as its common name indicates, is better known as an enemy of clover, on the roots of which it feeds. In 1901, however, it appeared in considerable numbers on sugar beet in Michigan, the smaller stunted roots being invariably infested. Injury was most apparent in June. The female mealy-bug measures a little more than one-twelfth of an inch in length, is reddish brown, and covered with a waxy or mealy secretion. The legs are dirty yellow, and from the sides project in the manner usual to this group 15 to 17 waxy filaments, the shortest being near the head and the longest near the tail, sometimes one-third as long as the body. It is related to the scale insects and is of similar appearance to the species shown in figure 63.

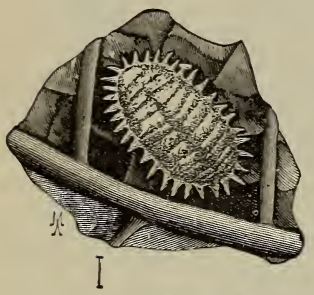

FIG. 63.—*Dactylopius citri:* female—enlarged (Division of Entomology).

Remedies.—The same methods of control that have been prescribed for root-lice would operate against the present species, with about the same results.

THE SEED-CORN MAGGOT.

(*Pegomya fusciceps* Zett.)[b]

Beet roots are subject to attack by the above-named species of root maggot. During November of 1902 we received complaint of what was with little doubt this insect from Colorado, where it was breeding in rot-infected roots, apprehension being expressed that

[a] Syn: *Coccus trifolii* Forbes; 1 [illegible] Report State Ent. Ill. for 1884 (1885), pp. 72–73; Pettit: Bul. 200, Mich. Agr. Exp. Sta. for 1901 (1902), pp. 193–194; Davis: Insect Life, Vol. VII, p. 172.

[b] See Bul. 33, n. s., Div. Ent., pp. 84–92, for synonymy, bibliography, etc.

although injury was not then noticeable the insects might do damage the following spring. Such a sequel is often to be expected, and it seems probable that many reported instances of injury by this and related forms of maggots are due to their habit of developing on decaying vegetable and other matter and afterwards attacking roots and taproots and other healthy vegetation of the vicinity. Most vegetables, more particularly beans, peas, and maize, are subject to damage, and cabbage, turnip, radish, onions, and sweet potatoes are also much affected. The insect which is generally distributed in the United States is shown in its different stages in figure 65. It resembles the beet or spinach leaf-miner previously considered. The particularly distinguishing characteristic of the fly consists of a row of short bristly hairs of nearly equal length on the inside of the posterior tibiæ of the male (fig. 64, *a*). The length of the wing is about one-fifth and of

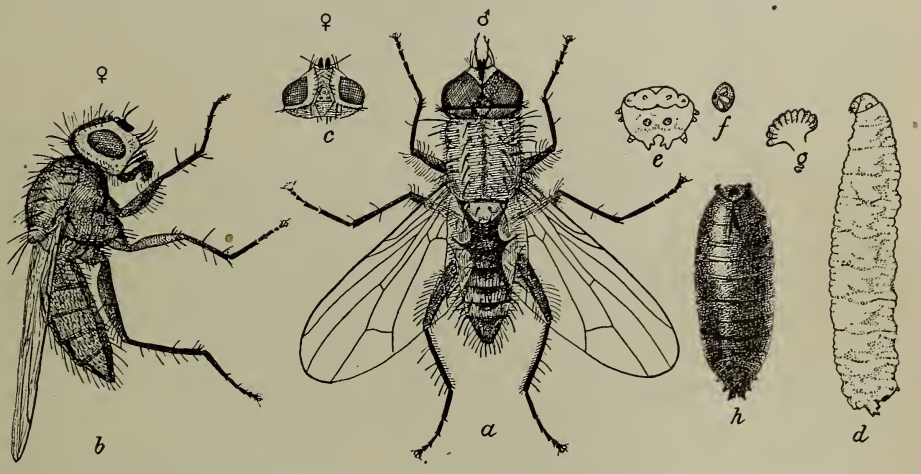

FIG. 64.—*Pegomya fusciceps: a*, male fly, dorsal view; *b*, female, lateral view; *c*, head of female, from above; *d*, larva, from side; *e*, anal segment of larva; *f*, anal spiracles; *g*, thoracic spiracles; *h*, puparium—all much enlarged (author's illustration, Division of Entomology).

the body about one-sixth of an inch. The maggot as well as fly resembles the onion maggot. There is little doubt that this insect is of European origin, and it is certainly increasing in destructiveness in this country.

Remedies.—Owing to the difficulty of destroying subterranean pests and the cost of chemicals for the purpose, such as bisulphid of carbon, we have to depend more upon methods of prevention. One way of deterring the parent flies from depositing their eggs consists in the use of sand soaked in kerosene—a cupful to a bucket of dry sand—which is placed at the base of the plants, along the rows. This also kills young maggots that may attempt to work through the mixture.

Fertilizers are also useful as deterrents, particularly when employed just before or after a shower has thoroughly wet the ground. They should be applied as nearly as possible to the roots, and the earth

should be turned away from the plants for this purpose. They possess the advantage of also acting as a stimulant to plant growth. Stable manure is apt to induce infestation, as this species is well known to develop in excrement and other decomposing material. As soon as plants show signs of wilting and maggots are known to be present, the injured plants should be promptly pulled and destroyed.

The above methods have been used with success against onion maggots and similar root-feeding species, and may be all that is required in the case of ordinary infestation of beets.

One of the best remedies for root maggots is bisulphid of carbon. It has been used with more or less success by Prof. A. J. Cook and others since 1880. In its application great care should be exercised that the liquid shall not come in direct contact with the roots of the affected plants. Directions for the treatment of plants affected by root maggots are furnished on page 14 of Farmers' Bulletin 145, a copy of which can be had upon application to the Secretary of Agriculture.

THE RED SPIDER.

The common or two-spotted red spider (*Tetranychus bimaculatus* Harv.) is usually present in most fields of sugar beet east of the Rocky Mountain range, but it is preeminently a greenhouse pest, and as a rule does comparatively little injury to plants growing out of doors. It is unique as a vegetable pest in that it is not a true insect, nor even a spider, as the popular term would imply, but a spinning mite. As the word mite indicates, these creatures are extremely minute, and are frequently not noticed until they become excessively numerous, as is apt to happen during summer droughts. They do considerable damage in flower and vegetable gardens, but attain their greatest destructiveness in connection with plants grown under glass.

The general appearance of the common red spider is shown in figure 65, highly magnified. The length of a full-grown individual is only about one-fiftieth of an inch. The ground color is reddish, usually more or less tinged with yellowish or orange, and most individuals have a dark spot on each side, due to the food contents of the body. The young are similar to the adults, differing in having only three pairs of legs, while the adults have four. This red spider spins threads, but does not use them for climbing. The threads are frequently so numerous as to form a tissue visible at a little distance. Webs are usually constructed on the under sides of leaves and within them the mites feed and lay their eggs from which the young develop.

This red spider is quite likely of foreign origin, but its distribution has not been carefully studied.

It is inclined to be omnivorous, attacking a wide range of plants. As the red spiders increase in number the leaves of an affected plant

turn pale and become stunted, and eventually the whole plant succumbs unless remedies are applied. Cuttings and young rooted plants are especially susceptible to injury, and more particularly in spring. These mites injure by suction, slowly reducing the vitality of plants until in time their functions are more or less deranged. Among ornamental plants that are much affected are violet, rose, clematis, minuet, pink, fuchsia, pelargonium, godetia, passiflora, feverfew, thunbergia, verbena, heliotrope, moonflower, calla, smilax, and Easter lily; while of other crops, beets, beans, sage, tomato, eggplant, pepper, cucumber, squash, cowpea, hops, and berries of various kinds are attacked. As a rule this species is not especially harmful to the sugar beet but is quite destructive at times in fields of other crops; for example, to beans, which have been badly injured in South Carolina in recent years.

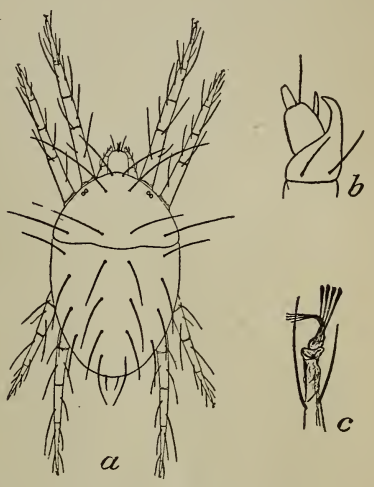

FIG. 65.—*Tetranychus bimaculatus: a*, adult; *b*, palpus; *c*, claws (after Banks, Division of Entomology).

Remedies.—This red spider is resistant to "gassing" or fumigation, either with tobacco or hydrocyanic-acid gas. It is, however, peculiarly susceptible to sulphur, a sovereign remedy for mites in general. Flowers of sulphur mixed with water at the rate of 1 ounce to the gallon and sprayed over the plants is of great value in its eradication; or the sulphur may be combined with a wash, for example, with strong soapsuds.

Potash, fish oil, whale oil, and other soap solutions, resin wash, and kerosene-soap emulsion are also valuable, and the addition of sulphur increases their effectiveness; but these washes are too strong for some delicate plants and are apt to injure them. For violets and similar plants, as they occur in greenhouses, no other remedy is used by florists generally than frequent syringing or spraying with water or with a solution of neutral soap. Directions for the application of the soap washes to violet and other greenhouse plants are furnished in Bulletin 27, new series, of the Division of Entomology (pp. 40–42).

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